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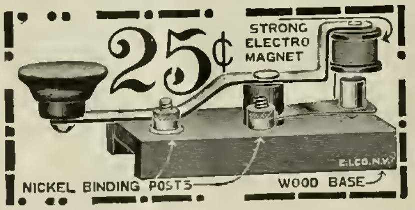

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Vol. VI Whole No. 63 JULY, 1918 No. 3

EDITORIAL

SCIENCE AND WAR

WE read a good deal lately about the futility of science in general, and the cry is long and loud that our much vaunted science instead of civilizing humanity and preventing wars, actually brings about wars and prolongs them. Parlor critics and the lay press, particularly, when things don't go right, are wont to ask cynically what science ever did to prevent wars, or if that were impossible, what it accomplisht towards shortening wars. Science is credited with accomplishing nothing but murderous machines and devices and of calling into being destructive forces without end. Science, in short, is held up to us as a modern Frankenstein Monster, which, escaping from our laboratories, now runs rampant and wreaks vengeance not alone upon those that brought it into being, but upon our entire civilization as well.

As to science creating wars, we might state that there have been wars ever since animal life appeared upon this planet. War is a natural phenomenon, the same as, let us say, a volcanic eruption. Neither is it confined to man alone. It is the eternal war for supremacy, whether it be the fight to death between two roosters, or the war between two great animal nations, such as for instance we witness in ants, where hundreds of thousands are fighting an equally large horde for supremacy, killing and maiming thousands and bringing back vast numbers as prisoners, henceforth to become slaves.

If we would only accustom our minds to the great and outstanding fact that there will be wars, small and large, as long as the earth endures, we would think of war in a totally different manner.

Therefore if we cannot altogether prevent war, with the aid of science we can certainly very largely prevent its former horrors and perhaps shorten it. Any student of history knows that great wars become less and less frequent as the centuries roll on, while statistics go to show that, considered as a whole, there have been far fewer wars during the past century, which marks the real beginning of science. As to the murderous war inventions created by science, such inventions only seem so murderous to the un-informed. Statistics show that far from killing more people, the reverse is the case. The number of men actually killed in action, as hit by cannon, rifle, poison gas and what not, *is less than 5% of the total casualties.* Even now, more men die from natural causes or from bodily diseases than from man-made scientific frightfulness. There were more people killed in the United States last year by automobile and railroad accidents, casualties in factories, etc., *than were killed on the entire Western front!* A careful study of statistics will bear out this statement.

In the former great wars as high as 70% of the effective fighting forces were lost by the ravages of disease, such as cholera, typhus, etc. Napoleon's great army after the return from Russia had dwindled down to less than 25% of its former strength, mainly thru disease. These were the former great horrors of war, now entirely conquered by science. Modern surgery, anesthetics and medical science as a whole are daily reducing the death toll among the unfortunate fighters struck down by the hand of man. Where formerly over 80% of the casualties were fatal, thanks to science this percentage has been reduced to less than 20. In other words out of one hundred maimed soldiers less than twenty now die of their wounds. While the entire balance may not be again fit for actual fighting, this vast percentage of disabled humanity is returned more or less intact to its peaceful pursuits. While it is not our intention to call war a benefit to humanity, the fact can not be denied that it has given medical science a wonderful opportunity to make new and important discoveries, to greatly reduce suffering, as well as treating diseases more intelligently hereafter.

Medical science alone has vast opportunities during the war, because it has more human material to work upon than in peace times. The fallen fighters will therefore not have died in vain. Each one of them will prevent thousands of others from dying during the peace that is to come.

H. GERNSBACK.

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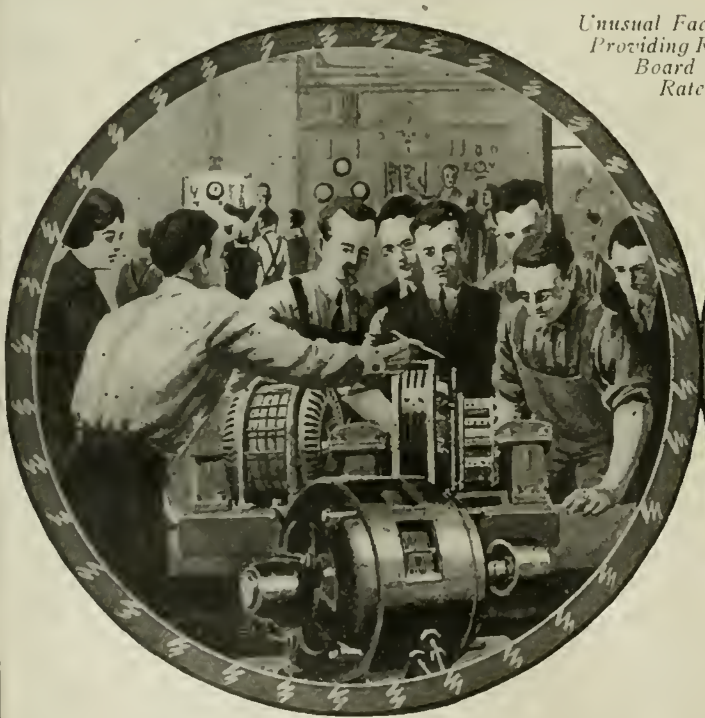

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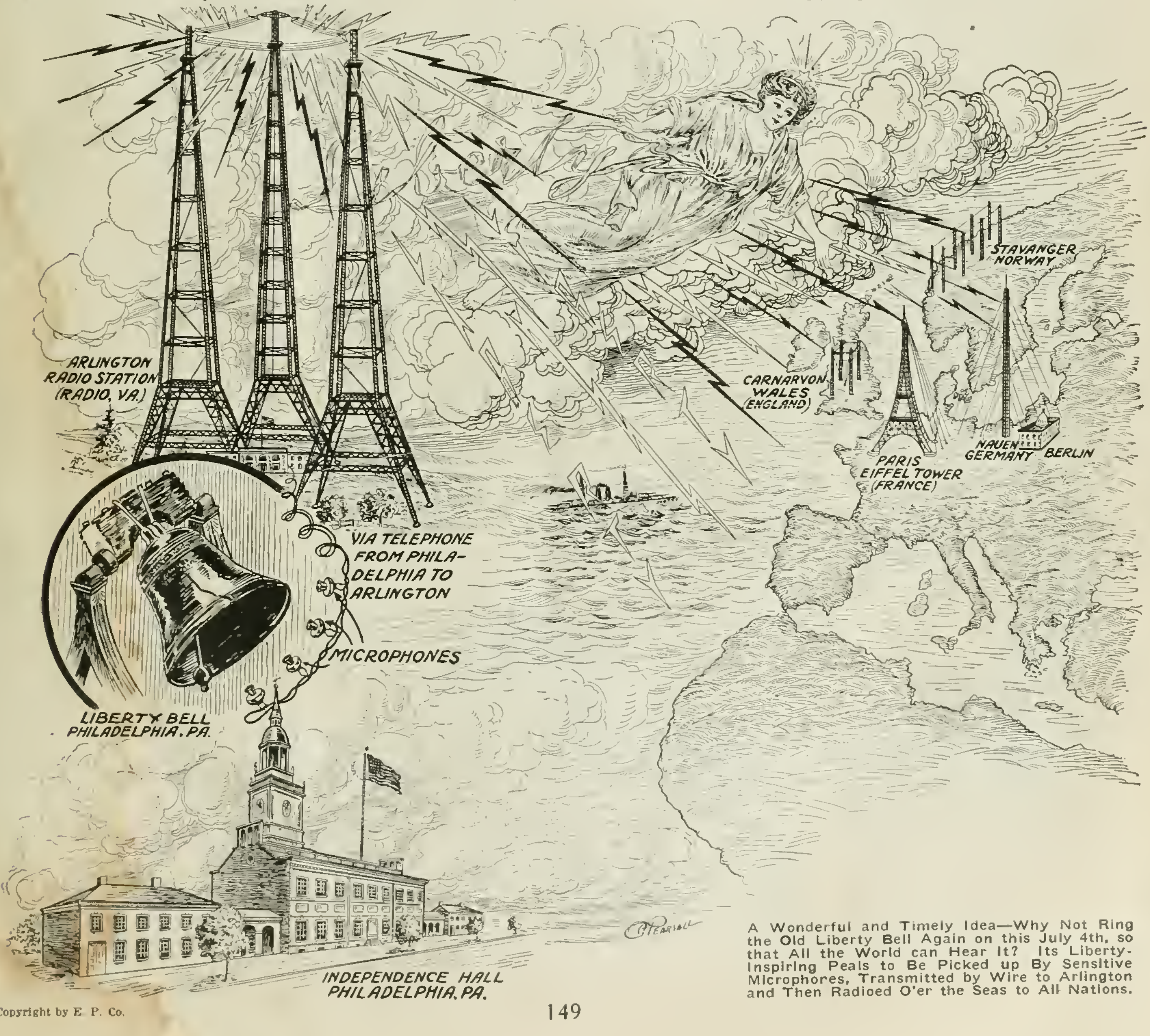
Vol. VI. Whole No. 63 JULY, 1918 Number 3

Liberty Bell Heard O'er the World Via Radio

By THOMAS REED

EVER notice how Tyranny always runs true to form? Take the average baby. Having reduced his home to subjection — buffaloed, bullied and seduced it to a finish—he picks the moon as the next subject for "annexation and indemnity": which process the moon resists, in its unwarned, moonlike way. Action and reaction being equal, the moon probably suffers somehow for its temerity; but the principal effect is observed on the foiled baby, in the well-known everyday domestic phenomenon of "tantrums."

When this happens, good nursery-psychology recommends diversion of the infant conqueror's mind by dangling before him any handy object, exclaiming, as engagingly as possible, "See the pretty doggy!"



A Wonderful and Timely Idea—Why Not Ring the Old Liberty Bell Again on this July 4th, so that All the World can Hear It? Its Liberty-Inspiring Peals to Be Picked up By Sensitive Microphores, Transmitted by Wire to Arlington and Then Radioed O'er the Seas to All Nations.

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or whatever Common Parlance names the selection.

You find the same psychology applied to the spasms of the undeveloped "Hun," peevish over the disarrangement in his Paris time-table, and the unaccountable hitch in his Picardy "negotiations."

The "doggy" in his case—the Nauen wireless-station—inspires this rapturous crooning:

"From the formidable towers of this establishment, the activities of which surpass all the fables of antiquity, waves are incessantly sent forth which acquaint the listening nations with everything that in our judgment they ought to know. This wondrous invisible ally, moreover, has constantly kept us acquainted with events which the enemy would gladly have withheld from us."*

Gosh! The Fables of Antiquity certainly have nothing on this blithe screed! Picture an innocent Nation cocking its ear to catch, amid a world of deception, the only clear, snappy, reliable **TRUTH**, "made in Germany" expressly for its enlightenment; and in the excitement being pilfered of a shy heart-throb—such as a Declaration of War! They say the Germans are always efficient, and this patent "diverter" of theirs proves it. It's a fine diverter. It would divert anybody.

Hist, while the histing is good! I have an idea.

You remember, a few years ago, how Mr. Carty, the Telephone Wizard, with his "Audions" and multifarious do-funnies, talked by wireless around half the world? Well, what's the matter with rigging 'em up again, and sending out a boom from the Liberty Bell, in Independence Hall?

And for a starter, what's the matter with mending our Bell, so we *can* boom it, good and proper? It's curious that while the "whole push," from song-writers up (or down) to financiers, are calling for the Liberty Bell to "ring again," they seem to mean the ringing figuratively, because it's cracked. But say, what does a crack amount to in any metal object, in these days of arc and acetylene welding? Science has moved on since we set the Bell away on a velvet cushion, and entered it up as "incurable." Broken cylinders and flywheels are being welded every day—huge things, beside which the Liberty Bell would look like a toy; mended, not merely to ring, but to resist high steam-pressure and enormous centrifugal force, and actually stronger afterward than before, since the original flaw has been eliminated.

Sure, it's the simplest thing in the world to fix our Bell, unless we prefer it broken and out of commission. But why should we—our Liberty isn't in that plight! Up to a certain point, the Bell followed our history pretty closely. We founded our Freedom in 1776, and the Bell rang it for us. But there was a flaw in the casting of our Independence, which we couldn't see. Slavery, which worked and widened till it broke the Nation apart; while the Bell, too, developed an "interior strain," and cracked from it. We welded the Nation's fracture together, better than new, in the heat of the Civil War—but right there, the Bell stopt accompanying history. Any reason why it shouldn't catch up again, now that we're setting our Liberty to the biggest task of all?

I sure wish that old Bell was fixt, and Mr. Carty's rinktums were working again! I'd like to have America designate a certain appropriate moment, when all radio traffic should stop, and for one whole minute the ether, everywhere around the world, should hum with "Liberty Vibrations" alone.

Anyhow, for the "Hun," up there in the "formidable tower of his establishment," it would be a reminder of what Pioneer Peoples do to the Pests of the earth. He's had examples, in "Pats" and "Anzacs"—I name 'em with respect. What with Indians and bears, rattlesnakes, bad-men, gipsy-moths and Trusts (to mention only a few of our Nearest and Dearest) we're so accustomed to swatting "varmints," that even a Central Power or two come all in the day's work. With an "Ah there, neighbor!" for the new arrival, we shoulder our eradicating-tools, and, whistling and busy, get after him.

Well, perhaps my scheme is only a pipe-dream! But "you know me, Al"—while my hopes are small of entertaining an angel unawares, I never could turn away a needy pipe-dream from the door!

*Cuxhovener Zeitung, quoted in *Boston Transcript*.

Hats off to Thomas Reed! Here is the germ of a wonderful idea—and a typical American idea, too. Not so long ago Mr. Carty of the American Telegraph and Telephone Company succeeded in making the human voice heard by Radio half way around the earth. The voice of the operator, stationed at Washington, was heard in Paris, France, and as far as Honolulu.

Mr. Reed suggests to transmit the metallic voice of old Liberty Bell by Radio thru the ether over this war-wrecked earth of ours, symbolizing the voice of Liberty in the most unique fashion possible. Yes, the German station at Nauen would hear the voice of Liberty Bell, too—Liberty ringing its way thru the ether, in *advance of the American Army*. The plan is simple and practically costless, as all the apparatus are on hand. What better date could be selected for the momentous event than July 4th, 1918. Let us hope that it will come off.

Readers, Wireless enthusiasts! When you see this in print write or telegraph to the Secretary of the Navy, the Hon. Josephus Daniels, Washington, D. C., asking him to send the voice of old Liberty Bell ringing over the battle-fields in France, on to Berlin, on July 4th. If 100,000 of you urge Washington, the great event will come off—a monument to the solidarity and enterprise of American Amateurs. Show this article to your local paper and urge it to reprint it at once, sending a clipping to us.

Now all together Amateurs! Show the nations that you are still on the map!

ELECTRIC LIGHTNING RECORDER HELPS OUR FLYERS

One of the most important things that military aviators wish to know about the air before venturing on long trips of several hundred miles, is the whereabouts of thunder storms. At all well appointed training camps, various meteorological data are recorded, such as changes in the barometer, wind velocity, etc.

The highly sensitive electrical recorder here illustrated makes a mark from a pen on a slowly revolving paper chart, secured to a clockwork driven drum, for every lightning flash occurring in the vicinity. In fact, so sensitive is this instrument that electric storms more than 200 miles away have been accurately recorded on it. It operates in a similar manner to wireless receiving sets of early type, which operated with a coherer or metal filings tube which responded to the electric waves.

The filings coherer is so sensitive that it will respond to all such unusual atmospheric disturbances, and thus lends itself well to such purposes as this. The filings are minute grains of nickel and silver or steel silver, a ratio of 90 per cent nickel or steel to 10 per cent silver is commonly used.

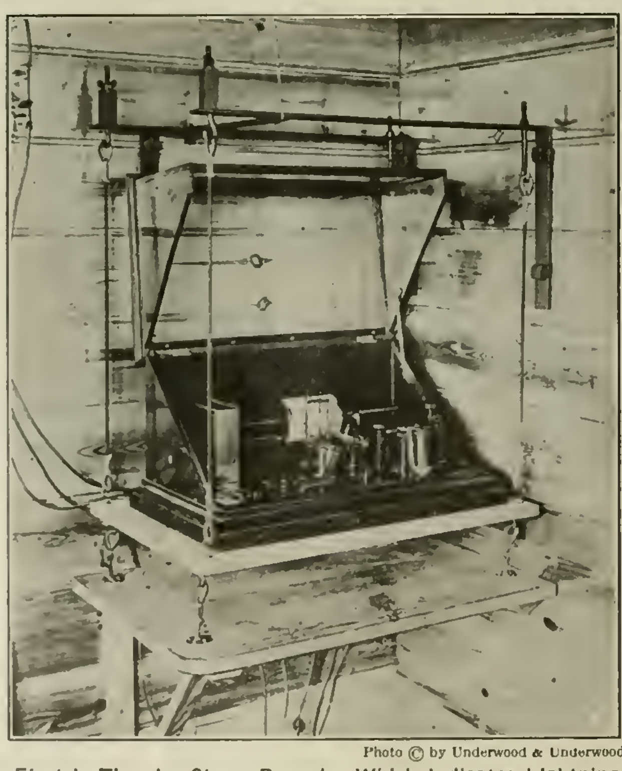


Photo © by Underwood & Underwood

Electric Thunder Storm Recorder Which Indicates Lightning 200 Miles Away.

A CENTURY OF LIGHT.

1815 to 1855, sperm oil and candles, average home used 25 candle hours per night, or 9,000 per annum—cost $22.

1855 to 1865, kerosene introduced with 50% more light, same cost of $22.

1865 to 1875, kerosene and gas—average household used 20,000 to 38,000 candle hours—cost $23 to $34.

1875 to 1885, kerosene reduced to 22c a gallon, gas to $2 per 1,000 cu. ft.; average family used 76,000 c. p. hours per year—cost $30.

1885 to 1905, kerosene disappearing—electricity and Welsbach gas mantle coming in, 200,000 c. p. hours average family used per year—cost $20.

1905 to 1915, average gas c. p. hours, 200,000. Average electric c. p. hours, 123,000 (due to saving thru switches)—cost $15.

Maximum light now of average families, 360 candles, or about 18 times that of a century ago.

With increase of 1700 per cent in amount of night lighting, reduction in cost of year's lighting is about 70%. Express another way, the cost of lighting per unit candle hour is less than 3% of what it was in the first half of the period.

Science and Radio in New Film Dramas

THERE seems to be no dearth of the "scientific movie" from present indications, with the vast number of serials and individual photoplays that are appearing all over the country. With the public mind literally fed up on the work of the German spies thru the daily papers, it is only natural to suppose that the screen should reap a rich harvest with film dramas showing these inner and secret workings of the Imperial German Government's espionage system in a graphic form.

The "Wireless Room" Featured in the "Eagle's Eye" Film Play, in Which the U. S. Secret Service Upset a Dastardly Teuton Spy Plot, Just in the Nick of Time, of Course.

A Huge Electro-Static Machine Is Used to Bring Back to Life an Apparently Dead "Villian" in "The Hidden Hand," a Recent Photo Play Serial.

First and prominent amongst these is the "Eagle's Eye," showing the length to which the German Government has resorted to hamper the work going on in this country. It is shown how a German agent's laboratory was raided by the U. S. Secret Service and the compositions discovered there tested, with the result that numerous bottles were found to contain disease germs of various kinds to be used in causing an epidemic of sickness among the longshoremen of New York, in order to paralize the shipping of supplies to the Allies.

The upper left photograph shows the wireless room of the Criminology Club of New York City. This club is a composite organization representing the Secret Service used thruout "The Eagle's Eye" to picture the activities of the body headed by Chief Flynn, the author of the picture. The picture shows a call being received, summoning the members to the Jersey stock yards at the time the plot to burn several thousand head of cattle and horses by the Imperial German Government, was discovered.

The remarkable "Life Restorer" pictured here (center) plays an important part in one of the closing episodes of Pathé's new Serial "The Hidden Hand." After many thrilling and exciting incidents in which an heiress and a Secret Service man, who is trying to prove the girl's identity and finally "falls" in love with her, figure prominently, we arrive at the scene where the villain of the thriller known as "The Hidden Hand" has been mortally wounded and his followers carry him away unconscious. They try to revive him, but without success and then "Verda," his right hand man, orders the henchmen to try the electric resuscitating apparatus on him. By its means he is brought back to life. The machine is essentially a large static machine and is very realistic in the semi-darkness with its large spark discharges in full operation. The basis for the introduction of the machine has been conceived by the author, Arthur B. Reeve, writer of the *Craig Kennedy* stories.

Last but not least we come to the General Film Company's new patriotic spy movie, "I'm a Man," in which Radio telegraphy plays a prominent part. (Lower photo.)

Frank Eisel, the son of German-born American parents, is a member of the High School Cadets. Frank's father is a banker who is desirous of having his daughter, Ruth, marry a Frenchman named DeCourcy, a director of the bank and very wealthy. Ruth has another admirer, David Smith, a young bookkeeper in the bank, but their growing attachment is frowned on by the father who favors DeCourcy. One day Frank notices a poster reading "Beware of Spies" and turning, sees DeCourcy talking with a stranger, and he at once suspects the Frenchman of being a spy. Events prove that he is right, as DeCourcy reveals himself to Frank's father as a German spy who has been masquerading for ten years as a Frenchman. On account of operations made thru the bank, he not only compels the banker to keep silent, but insists that he be received into the Eisel home.

Here he learns of Frank's amateur wireless outfit and demands that the father get the boy out of the way so that he may use it. This the father does, but Frank returns unexpectedly and intercepts a message regarding the burning of some oil wells, and he saves the wells at the risk of his life. When Frank is hovering between life and death, Dave Smith, now the accepted suitor of Ruth, notices a change in the boy's condition and instantly spring to the boy' side, revealing a secret service badge that he is wearing. Thus Frank knows that his father is no longer under suspicion, and the banker is also overwhelmed with joy, realizing that Smith knows he is a true American, and he turns to Frank saying, "Frank, my son, you are a man."

The photograph shows young Frank Eisel operating his radio set while in close proximity may be seen his young lady love, Miss Dolly Hope.

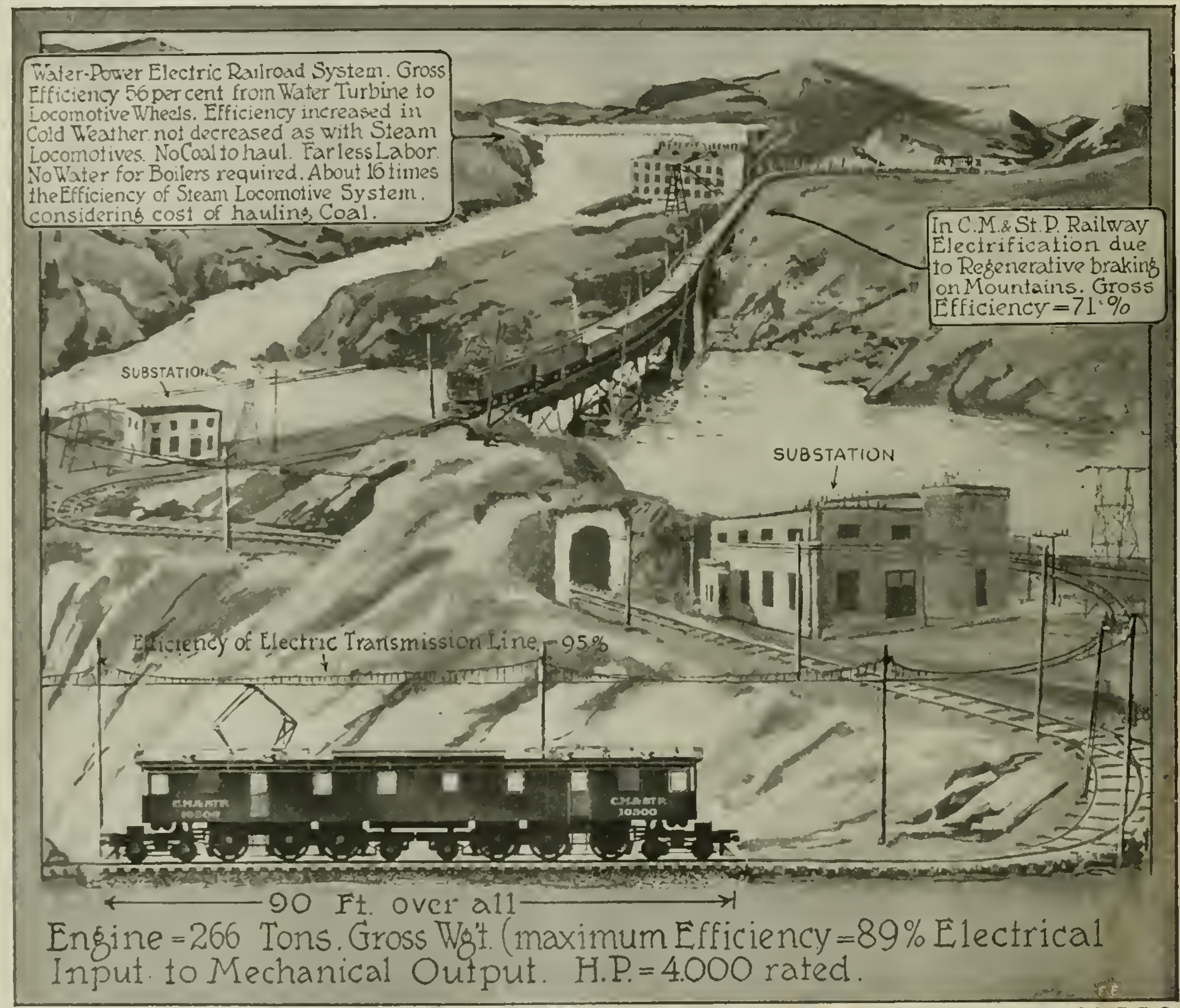
Scene from New Film Drama "I'm a Man," in Which a Wireless Amateur Holds the Center of Interest Thru Many Exciting German Spy Maneuvers.

The chief inventions used in the present war as distinguished from the Napoleonic wars: Steamship, submarine, air craft, high-power guns, smokeless powder, breech-loading gun, rapid-fire gun, revolver, automatic pistol, telephone, wireless telegraphy, automobile, poisonous gas.

Electric or Steam Railroads—Which?

By H. WINFIELD SECOR, Assoc. A. I. E. E.

YOU stand enthralled in a beautiful gorge among the Rockies, admiring the supreme grandeur of nature, when—with a roar like distant thunder—a long, snake-like train of steel cars, headed by a smokeless demon that fairly bristles with power, dashes by you at a mile-a-minute speed.



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The Above Illustration Shows In a Marked Manner the Various Losses Occurring In a Modern Hydro-Electric Railway System, and In Comparison With the Illustration On the Opposite Page, It Is Evident to Everyone that this Is the System of Not Only the Future, But the Very Near Future, Particularly When the Experts of the United States Fuel Administration Come to Figure Up the Millions of Dollars Actually Thrown Away Annually In Hauling Coal Back and Forth Over the Railroads.

It's the Chicago, Milwaukee and St. Paul R. R. *"Olympian,"* the finest transcontinental train in the west, speeding on her way to the Pacific coast. She's driven by "juice"—3.000 volts of it, and thousands of amperes, all transmitted over a thin copper wire from mighty water-falls, high up in the mountains. There the electrical engineers have placed their electric generating stations, where gigantic turbines spin the dynamos all day long, reclaiming the power in the water—at present over 150,000 horsepower is developed by these hydro-electric plants, the most efficient of all methods in the production of electrical energy.

Now that the whole country has been aroused as to the countless possibilities of electrifying the railroads, and other arteries of commerce and industry, by the recent reports from engineers connected with the national government, everyone is more or less interested in the comparative costs of operation for such electrification, and always, always the question comes up —Will it pay? The answer has been pretty well settled by the facts and figures presented in the past year or two by our ablest engineers and particularly by the report of the railroad operating the longest electrified mileage in the world, the Chicago, Milwaukee and St. Paul system, which now haul all their passenger and freight traffic over the Rockies from Harlowton, Montana, to Avery, Idaho, a continuous run of 440 miles. This railroad is now arranging to "electrify" to the Pacific coast, so successful has the present installation proved. This is what Mr. C. A. Goodnow, assistant to the President of the C. M. & St. Paul R. R., in charge of the electrification, recently said: *"Our electrification has been tested by the worst winter in the memory of modern railroaders. There were times when every steam locomotive in the Rocky Mountain district was frozen, but the electric locomotive went right along. Electrification has in every way exceeded our expectations, not only as respects tonnage handled and mileage made, but also the regularity of operation."*

Notable among large steam railroad electrifications are the following: 1896, Baltimore & Ohio Tunnel; 1906, New York Central Terminal; 1906, West Jersey & Seashore; 1909, Great Northern; 1910, Detroit River Tunnel; 1910, Pennsylvania Terminal at New York; 1911, Southern Pacific; 1913, Butte, Anaconda & Pacific; 1916, Chicago, Milwaukee & St. Paul; 1917, Victorian Railways, Australia; besides a host of others now joining the ranks of believers in *railroad electrification.*

We may profitably study for the moment this wonderful engineering feat so successfully carried out on one of the greatest railroads of the West.

The tracks of the mountain district of the Chicago, Milwaukee & St. Paul Railway, in surmounting the obstacles imposed by the Rocky Mountain and coastwise ranges, represent the solution of one of the most difficult problems ever mastered by railway engineers. Out of this section of rugged mountain railway, including many long grades and short radius curves, four steam engine divisions were selected for electrification, aggregating 440 *miles in length.* Steam engines were first abandoned on the Three Forks-Deer Lodge division.

115 miles long, and crossing the main Continental Divide, thus giving the electrical equipment its initial tryout under the severest service conditions of the entire system. The first electric locomotives were placed in regular service on December 9, 1915, and during the month of April, 1916, service was extended to Harlowton, making a total of 220 miles of electrically operated road. By the first of November, 1916, steam engines were superseded over the entire distance of 440 miles, from Harlowton, Montana, to Avery, Idaho.

This project is the most extensive steam railway electrification in the world, the length of haul being nearly six times as great as any trunk line now operating with electric locomotives. The length of track between Harlowton, Montana, and Avery, Idaho, is approximately equal to that from *New York to Buffalo or from Boston to Washington.*

In crossing the three mountain ranges included in the electric zone, there are several grades of one per cent or more, the most difficult of which is the 21-mile two per cent grade between Piedmont and Donald, and the longest the 49-mile one per cent grade on the west slope of the Belt Mountains.

The curvature is necessarily heavy, the maximum being 10 degrees. There are also numerous tunnels in the electric zone, 36 in all, of which the longest is the St. Paul Pass tunnel, over a mile and a half in length, thru the ridge of the Bitter Root Mountains.

The passenger service consists of two all-steel finely equipt transcontinental trains in each direction, the *"Olympian" and "Columbian,"* and a local passenger train in each direction daily between Deer Lodge and Harlowton.

Freight traffic thru the electric zone comprises from four to six trains daily in each direction. Westbound, the tonnage is made up of manufactured products and merchandise for Pacific Coast points and foreign shipment. Eastbound tonnage includes grain, lumber, products of the mines and some live stock.

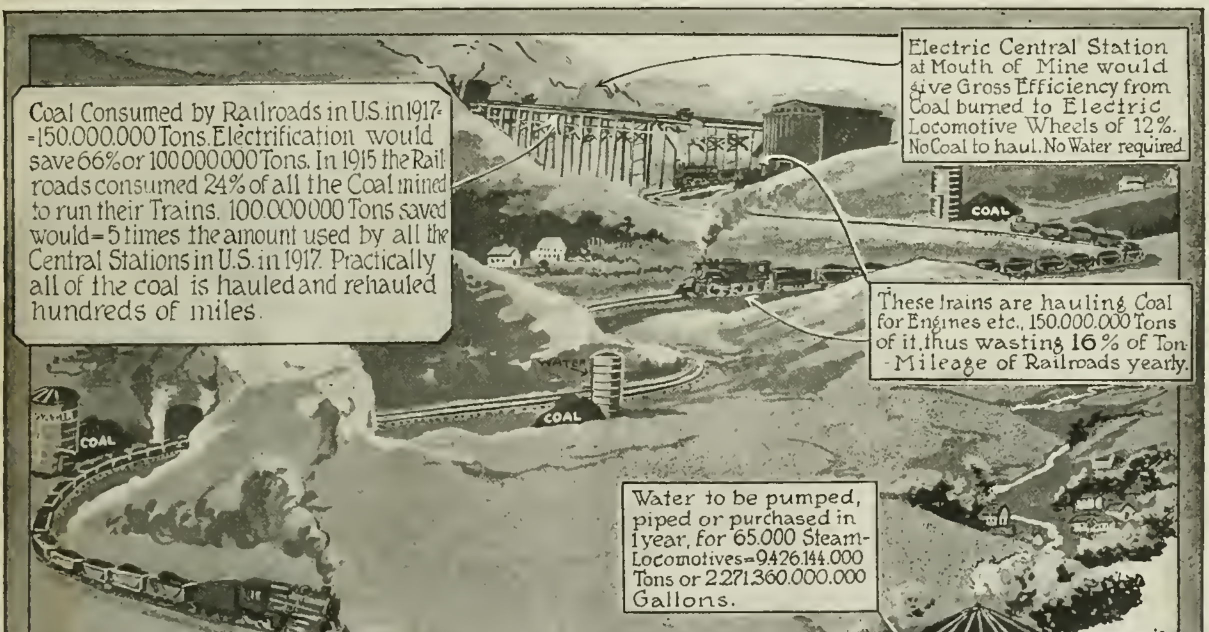
Electrification promises a very marked reduction in running time, not to mention the freedom from cinders and smoke always incident to the use of steam locomotives. It has been found, for example, that on the 21-mile two per cent grade from Piedmont to Donald, the electric locomotive can *reduce* the running time of passenger trains from 65 minutes to approximately 40 *minutes.* On the run from Deer Lodge to Butte, which, under the steam locomotive schedule, required an hour and 20 minutes (80 minutes), *a saving* of approximately 30 *minutes* can be made.

In the freight service, it has been found that on the first division where the steam locomotives have required 10 *to* 12 *hours* to make 115 miles, electric locomotives can meet a schedule of from *seven to eight hours* for the same distance. The heavy grades and frequent curves at certain points offer serious obstacles to steam locomotive operation even in the summer time, but with winter temperatures as *low as* 40° *F.* and heavy snowfalls in the Bitter Root Mountains, serious delays have occurred, owing to engine failures or to *inability to make steam.* The capabilities of the electric locomotives are in no way impaired by cold weather or by inability to obtain fuel or water in case of snow blockades. During a series of record-breaking temperatures in December, 1915, the powerful Mallet engines were frozen up at different points on the system and the new electric equipment was rapidly prest into service to replace them. On several occasions electric locomotives hauled in disabled steam engines and trains which would otherwise have tied up the line.

In cold weather, such as we experience right thru the winter in the East, not to mention 40° to 60°-F. in the West, the steam locomotives suffer severely in loss of all-around efficiency. The severe cold makes it harder to keep the boiler parts heated up, and much of the heat from the coal is used up simply to raise the water to the steaming point, owing to its extremely low temperature. The steam locomotive is about the most inefficient prime mover we know of for practical purposes. It practically never realizes above 7 to 8 % over-all efficiency—i. e., in transforming the energy in the coal to tractive force at the driving wheels and draw-bar. The remaining 92 to 93% is wasted in friction and heat losses.

Recent tests in the locomotive laboratory of one of the largest American railroads have shown that under *road* conditions the best steam engine realizes nearer 7% than

(*Continued on page* 207)



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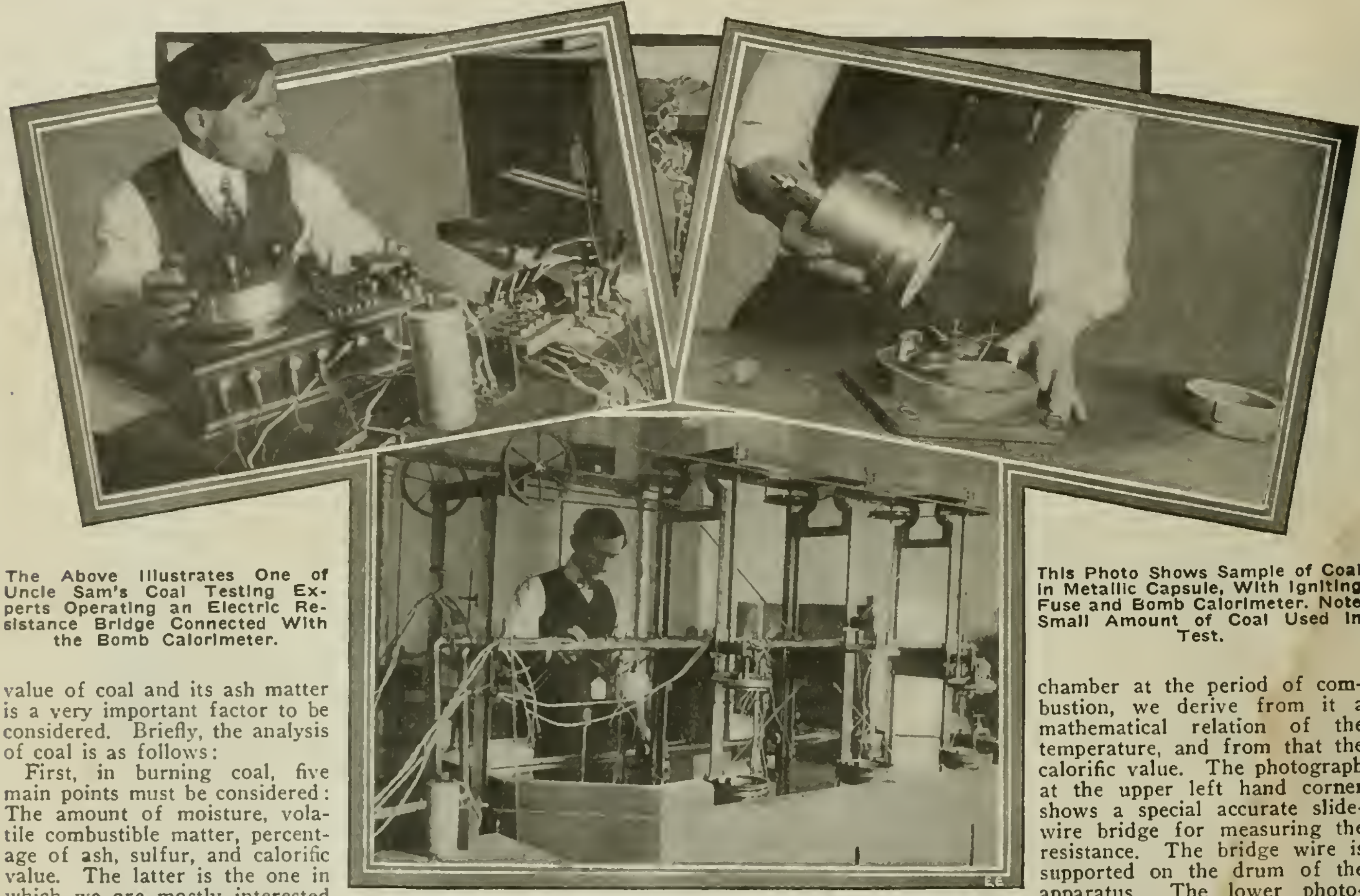
Possibly You Never Stopt to Think of the Great Coal-Handling and Operating Losses Sustained Annually by the Steam-Operated Railroads All Over the United States. These Railroads, as the Above Data and Illustration Show Vividly, Consume In One Year 24 Per Cent of All the Coal Mined, Just to Run Their Trains! It Has Been Estimated by a Great Engineer That "Electrification" of These Railroads Would Save 66 Per Cent or 100,000,000 Tons of Coal Annually.

How Uncle Sam Tests Coal by Electricity

By SAMUEL COHEN



The Above Illustrates One of Uncle Sam's Coal Testing Experts Operating an Electric Resistance Bridge Connected With the Bomb Calorimeter.

This Photo Shows Sample of Coal in Metallic Capsule, With Igniting Fuse and Bomb Calorimeter. Note Small Amount of Coal Used in Test.

Photo © International Film Service

These Men, Experts at the U. S. Bureau of Mines, Do Nothing But Play With Coal. The Calorimeters Above Are Used to Gage the Heat Value of Coal in B. T. U.

HOW much heat do we get from different grades of coal? This is the very real and important problem that confronts our manufacturers in operating their plants. The subject of determining the heat unit value of coal and its ash matter is a very important factor to be considered. Briefly, the analysis of coal is as follows:

First, in burning coal, five main points must be considered: The amount of moisture, volatile combustible matter, percentage of ash, sulfur, and calorific value. The latter is the one in which we are mostly interested in the present instance, since electricity plays a very important rôle in its determination, while the first four items are determined by purely chemical methods.

The coal sample in question goes thru a regular analysis before it is clast and the results of the approximate analysis gives only a general idea of the heating value, by indicating the class in which the fuel belongs. Anthracite coals are characterized by a small percentage of volatile combustible matter (usually less than 10 per cent), while bituminous coal contains a large amount of this constituent (usually 30 to 40 per cent), while in cannel coal this is the main constituent. The proportion of this constituent is dependent on the amount of hydrogen present, as this element forms volatile compounds with the carbon. When hydrogen burns, it evolves a much larger amount of heat than is produced by the combustion of the same amount of carbon. Coals containing a large proportion of volatile combustible matter have usually, therefore, high calorific values, and water which absorbs heat when it is converted into steam. It is evident that the calorific value of a fuel can be calculated from the percentage of carbon and hydrogen present. This method is subject to an error, arising from the fact that the heat combustion of hydrogen and carbon varies with the nature of their chemical combination. Direct methods for determining calorific values are therefore more reliable. The instrument devised for this purpose is called a *calorimeter*.

The calorimeter consists of three essential parts, namely:—A combustion chamber, a tank of water with a delicate thermometer for indicating the amount of heat absorbed, and an insulating device to prevent the external heat from reaching the water and the thermometer, and also to prevent the heat generated in the combustion chamber from escaping the apparatus.

A certain quantity of the sample coal is placed in a small container. This quantity is usually one gram. With this coal a certain amount of oxidizing agent is added, and this may be sodium peroxid. In the same container a fuse wire is placed and properly connected to an electric power source so as to ignite the coal mixture at a desired time. The upper right hand photograph shows clearly the sample of coal in the calorimeter capsule. Note the fuse wire on top.

The temperature of the coal when in a burning state is directly determined by means of a special electric thermometer which is inserted in the coal chamber. This thermometer consists of a fine high-resistance wire, whose resistance is determined at the beginning of the test and at the period of combustion. The resistance increases with temperature rise, and since there is a definite relation between temperature and resistance, it is therefore possible to determine the temperature corresponding to the resistance. So by measuring the resistance of the wire in the coal chamber at the period of combustion, we derive from it a mathematical relation of the temperature, and from that the calorific value. The photograph at the upper left hand corner shows a special accurate slide-wire bridge for measuring the resistance. The bridge wire is supported on the drum of the apparatus. The lower photograph shows four of these calorimeters. The wires are used to connect the igniting fuse wire with the current supply, while some of them run to the electric thermometers.

This work is of extreme importance insofar as it tells the purchaser the maximum amount of heat he can possibly obtain from a certain grade of coal.

ELECTRIC SAW MILLS.

Electrically operated saw mills of the portable type are said to be rapidly gaining in favor among lumber men. In localities where water power is abundant and has already been partially converted into cheap electric power the portable sawmill is especially popular. According to the president of a firm which is manufacturing electric portable sawmills, the demand is fast increasing in the South and West of the United States at the present time.

TELEPHONE CABLES IMPROVE WITH AGE.

It is found that the insulation resistance of telephone cables increases with the age of the *cable*, when it lays in the ground, because the moisture it possesses appears to be dried out.

NEW DENTAL AND X-RAY MOVIES.

DR. E. L. CRUSIUS of New York city has announced that in co-operation with one of the leading film companies he had perfected a system for taking X-ray moving pictures which is expected to be of great service in treating injuries to the joints.

Among the pictures taken thus far are illustrations of the movements of the knee, ankle, and elbow. Dr. Crusius says that the photographs show not only the bones but the muscles, and that by moving a joint that has been injured and photographing the action of muscles and movements of bones it will be possible to find out just what parts have been injured and the treatment required.

A physician desiring to have the heart of his patient tested sends him to a radiologist to have an X-ray taken. The picture can show the size, position, and appearance of the organ, but it can not show the rising and falling of the heart beat. Again, the radiologist, during the examination, can take note of the manner of the beat, but he can not pass his observation on in its actual form. The same is true of X-rays of the lungs, stomach, intestines and other organs; than can not be shown *functioning.* An X-ray photo of the living stomach is shown herewith.

Thru the use of the new machine radiologists will be enabled to take pictures showing the actual continuous movement of the part of the body under observation. As soon as the invention is completed Dr. Crusius expects to offer it to the Government, which might use it for examining soldiers before entering the service and for examining wounded soldiers so as to ascertain the full extent and degree of their injuries.

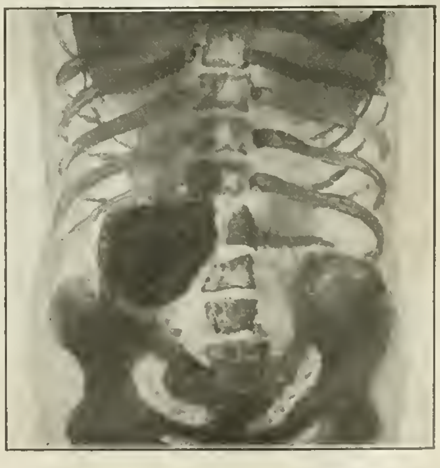
The Dentists of To-day do Not Depend on Merely Looking at the Teeth—They Take Radiographs of Them, Which Often Show Defects That Effect the Patient's Whole Constitution.

Another phase of the motion picture X-ray is the part it may play in the educational world. Thru it a motion picture can be taken, for instance, of the path followed by a swallow of water or a mouthful of solid matter. It will present to view to the student and ordinary practitioner what up to the present time has been visible only to the eyes of the Roentgen-ray specialist.

By the old method of dental treatment, when only outward signs could be read, the dentist would treat the diseased tooth and unwittingly leave the abscess on the sound tooth to continue its destructive work until the tooth loosened or decayed.

Malformations of this kind, and especially abscesses on sound teeth, cause neuralgia, rheumatism, headache, intestinal indigestion, enfeebled eyesight and general lassitude.

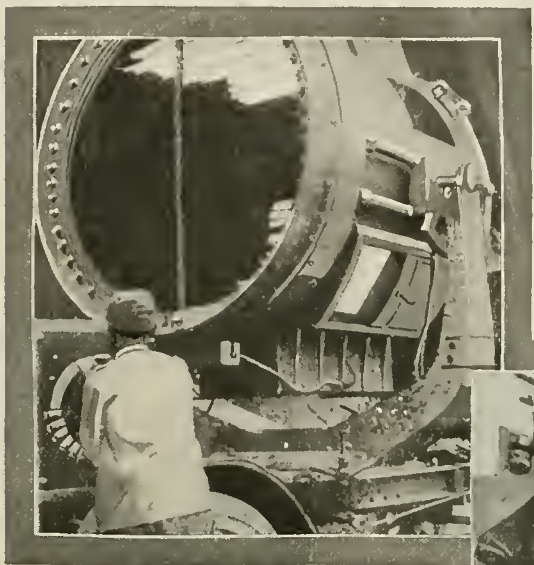
The necessary interest on the part of the physician today in the pathologic conditions of the oral cavity in teeth demands some study on the part of the medical fraternity. It is a great error to treat patients for all the ills on the calendar and ignore the teeth, a very prevalent source of constitutional disease, writes one authority. Of the two X-ray photos here reproduced, showing the teeth, one shows an alveolar abscess involving the root of tooth, while the other presents a complete root filling and the amputation of the same tooth. Many teeth now sacrificed may be successfully treated and give life-long service.

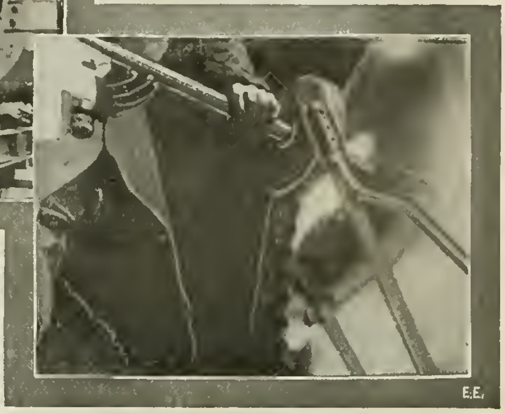


X-Ray Photo of the Living Stomach. A Bismuth Meal Is Given the Patient Before Taking Such Radiographs.

Monster Italian Searchlight

Recently we had the pleasure of seeing some very interesting official Italian war films, certain views of which are reproduced here as of especial interest to electrical people. Most every one has read of the wonderful work done by the Italian army this past winter in the mountains in the campaign against the Austrian army; of the almost insurmountable difficulties that have been met and overcome, and it is only thru the medium of the moving picture that one is able to grasp the significance of this vast work.





Monster Electric Searchlight Used in Fighting Night Battles on the Italian Front. Its Size Can be Judged by Comparison with the Figure of the Operator.

We see the Italians transporting guns over the mountains by means of long steel cables and aerial cars or bombarding the enemy during the night under the glare of a hundred powerful electric searchlights. In the morning following, the infantry takes up the charge to gain and consolidate the ground which has been cleared by the heavy shell fire, and it is during these scenes that the dangers the camera man is exposed to, with the hail of bullets breaking all around him as he merrily (?) turns the crank, are observed.

Not a small part is played in this drama by electricity. To assist the heavy artillery in its night attack great searchlights are used to spot positions, note movements of the enemy, and to see if a counter-attack is being contemplated. Some idea may be gained of the size of these Italian army searchlights from the accompanying views; in the original film a soldier is seen to enter the searchlight thru the trap-door in the base of the light in order to adjust the huge carbons which are used; one of the present photos showing the operator holding the massive carbon rod, which measures 3 inches thick by 3 feet in length. Later he steps down and may be seen starting the machine wherein he looks like the proverbial peanut on the watermelon.

The full significance of photography in the World War can only be realized in a small way from this brief resumé of course, and only when we have returned to peaceful pursuits again and witness all that has been preserved thru the medium of the photographic film and plate will we fully appreciate the invaluable records that we can pass on to posterity.

The American Army now in France is being equipt with all the latest electrical appliances. Searchlights mounted on telescoping towers are being supplied to our forces as fast as conditions at home will permit.

Will The Germans Bombard New York?

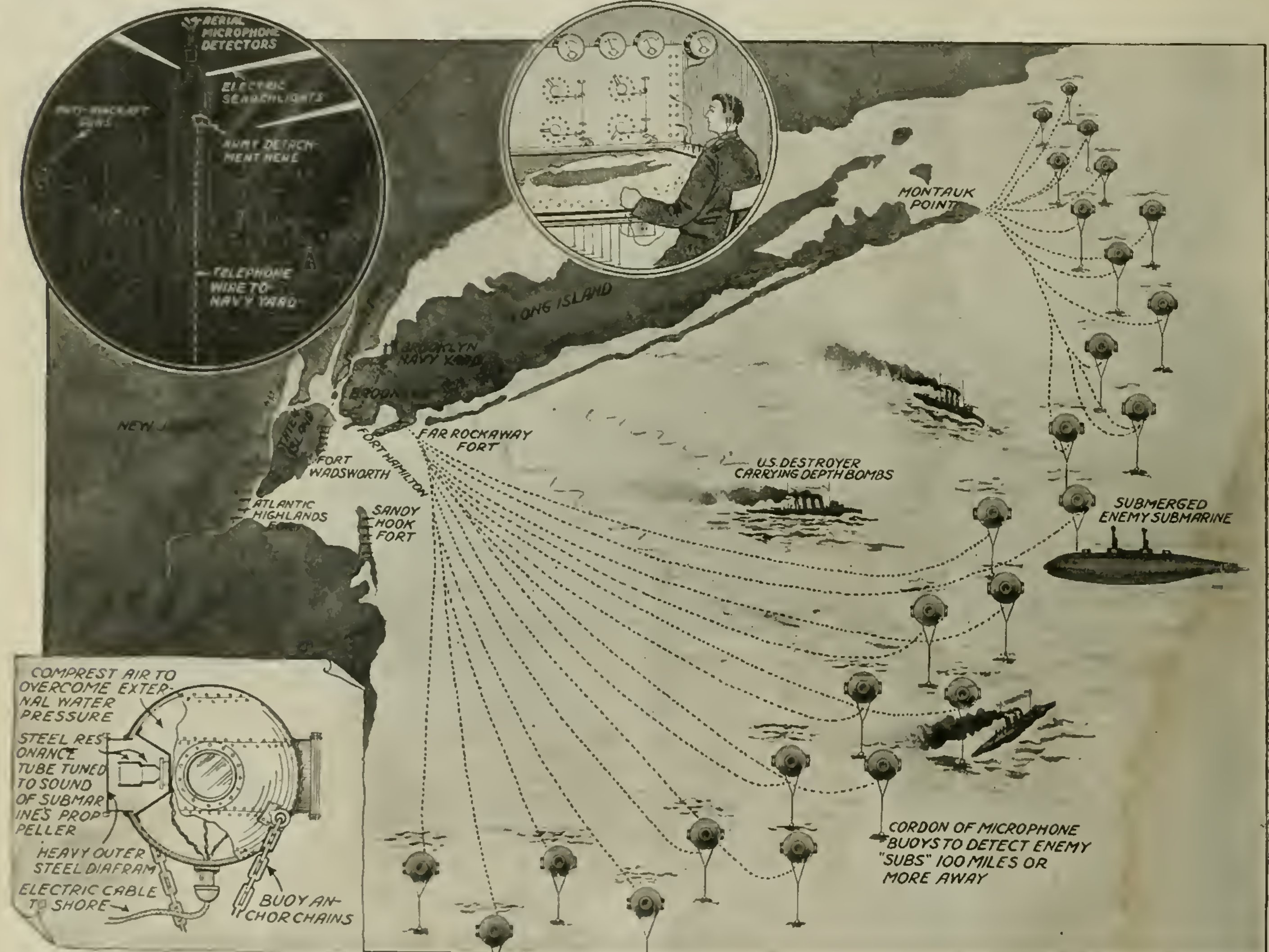
By H. GERNSBACK

Of late we have been reading quite a good deal in the daily press about the possibility of an aerial attack on American cities by the Germans. Many anxious inquiries have come to the writer's desk from readers of this periodical, asking if there was any chance or probability of an aerial raid at this time. Many people seem to think that raids are impending this year, while equally as many are skeptical about it. It is the purpose of this article to point out certain relevant facts relating to the above, and we will try here to show the technical aspect of the idea.

Let us first set our minds straight about the military reasons for bombarding cities, whether these be American, French or English. Every time the Germans bombard London or Paris, immediately the cry goes up about the German "baby killers" and the frightfulness in general. Bitter remarks are not wanting in the press, as well as by private individuals, and the German practise is decried quite properly in most violent as well as abusive language. The thought seems to be uppermost in the mind of every lay individual that there is no military reason for bombing open and undefended towns while at the same time killing women and children. Now, without wishing for one second to defend the German practise of throwing bombs from the skies upon helpless people, there certainly is a good military reason behind it all. It is a very expensive as well as risky undertaking to send aeroplanes over our Allies' lands, and you may rest assured that it is not for the sole purpose to demoralize the inhabitants or to practise frightfulness. The Germans are too practical a people, and as a rule do not waste time, effort and costly ammunition just for frightfulness alone *if it does not bring a military advantage.* What the lay critics seem to leave out from their reflections entirely is this: If the English or the French were positive that the Germans would not or could not bombard their cities, they would not have to keep hundreds or thousands of aeroplanes inland for defensive purposes, and these aeroplanes could then be used to the greatest advantage at the front.

In other words, by sending, say a dozen, bombing machines over London, Germany effectively ties up several hundred English aeroplanes inland, which then obviously cannot be used against the Germans either at the front or to bomb German cities. Therefore, it is good business from the German viewpoint to send a few machines over London or Paris at irregular intervals, thus locking up a large quantity of English or French aeroplanes that might be used to vastly better advantage against the Huns. This is the main reason, and probably the only reason why these raids occur and from a military viewpoint must occur. The Germans have no choice about it, for if they did not do it, the Allied aeroplanes would overwhelm them at the front. Naturally this would constitute a great aerial supremacy by the Allies, which the Germans are striving hard to avoid. If we were in the same position, we would be forced to do exactly the same thing, but of course not as ruthlessly as is practised by the Boche aviators. It is safe to say, therefore, that with less than one-tenth per cent of the total German aeroplanes, this small percentage locks up as high as twenty-five per cent of the available Allied aeroplanes *away from the front.*

This brings us to our own shores. At the present time America is making a su-



This Illustration Shows a Novel Suggestion How to Indirectly Protect New York City from Possible German Air Raiders. Mr. Gernsback's Idea Is to Throw a Cordon of Submerged Microphone Buoys Far Off from the Coast as Shown. The Nearest of These Buoys Would Be About Thirty Miles Distant from New York Harbor, and the Buoys Might Be In Two or Three or Four Rows. As Indicated, Each Buoy Is Connected with the Navy Yard by Means of a Cable. If a German Submarine Carrying Aeroplanes Should Come Within Range of These Buoys, Its Sound Would Be Detected Immediately, and the Navy Yard Could Then Dispatch the Destroyers to Frustrate the Attempted Aeroplane Raid. The Submarine Buoy Is Entirely Practical, Having Been Tried in France Some Years Ago.

preme effort to ship thousands of aeroplanes to Europe. The ocean lies between us, and we are in a way comparatively safe from aerial attack *now*.

The German military command, however, cannot view the situation but with great alarm, and in self-protection it will be necessary for them to lock up a vast amount of American aeroplanes on our own shores, if the trick can be done. In other words, the Germans will try desperately to prevent us from shipping all of our aeroplanes to Europe, and they will stop at nothing to gain their end. Blowing up factories and munition plants in America by their agents will not help them much, and they will not be able to torpedo but a very small percentage of ships carrying over these aeroplanes. What simpler remedy then is there for their problem than to bombard occasionally, say, New York, Boston or Philadelphia, thereby practically forcing us to keep at home a vast fleet of aeroplanes. This is the military aspect of it and for this reason it would be suicide in allowing ourselves to live in a fool's paradise. We should always remember that we are facing a formidable enemy who stops at nothing to gain his end, and who has the resources and the brains to often accomplish the impossible. Witness the 76-mile gun which was so preposterous a few months ago. Witness the "Flying tank,"—an armored battle-plane,—which has just made its appearance over the Allied lines to our great discomfiture. To the writer's mind, who does not desire to be an alarmist, there is but little doubt that some of our American coast cities are in for an aerial raid. But how can it be accomplished?

Zeppelins may safely be left out of consideration. These huge aerial sausages have already been eliminated by the British as well as the French, and they do not venture very often over our Allies' lands of late. They are too vulnerable, offer too big a target, and are easily shot down by anti-aircraft guns, as well as by attacking aeroplanes. There seems then little possibility of a Zeppelin making its way over the Atlantic at the present time of writing. Even in peace times it is questionable if a Zeppelin could cross the ocean at the present development of the craft. The tremendous weight of the fuel alone is against such an undertaking, let alone carrying bombs, adverse atmospheric conditions, etc. This leaves the aeroplane.

While is seems quite possible, and as a matter of fact very probable, that the Atlantic will be crost by an aeroplane very shortly, we do not think that the Germans lying so far inland will try to make a flight across the entire breadth of the Atlantic ocean at this time. The great weight of the necessary fuel would be against such an exploit, and would seriously handicap the carrying of the necessary bombs as well. But we have of late been reading that the Germans have built super-submarines from five to ten thousand tons, and we understand that some of these have actually been launched. We know that submarines can readily cross the ocean, as has been proven by the *Deutschland* as well as by our own submarines, which have frequently crost not only the Atlantic Ocean, but the Pacific as well. If the Germans have a 10,000-ton submarine, it will be a very simple matter to stow away in the hold of such a submersible anywhere from three to five "knocked-down" aeroplanes, and which can be readily assembled within a few hours' time on a temporary platform on top of the submarine.

This problem offers no technical difficulties whatsoever. As a matter of fact, it has been declared as eminently feasible by many authorities. A submarine as large as ten thousand tons has quite a breadth, and is of course of great length. A light steel or wood platform can be readily put in place within a few hours' time, and then the crew will find but little difficulty in assembling the aeroplane and launching it from this platform. Our front cover shows the idea better than words, and we are leaving the details to the reader's imagination. We again wish to point out that it will be a comparatively simple matter for the Germans to do this. If the attempt is made the Huns will probably send over a number of submarines, several of them being used to carry areoplanes only, the others to act as a sort of guard to ward of hostile vessels, etc. The attack will most likely be made at sunset when the air is usually calm, and when the submarines will stand the least chance of being detected. It should be remembered that a submarine lies very low and is practically unseen by another boat at a distance of five miles. As far as New York is concerned, or for that matter any of our coast cities, none of them are as well protected geographically as Paris or London, and there would be practically no warning of an impending raid. Suppose that the German submarine carrying the aeroplanes was lying fifteen or twenty-five miles away from New York. Then it would only take the bombing aeroplane from ten to fifteen minutes to reach the city, and the chances of discovery would be very small for the submarine. In all probability a city, as for instance New York, would prove easy prey for the raiders. And what a target New York offers!

THE AUGUST "E. E."

Among one hundred other timely articles to appear in the August issue are the following, which cover, the fields of Electricity, Radio, Physics, Experimental Chemistry and Astronomy:

"An Aerial Mono-Rail Flyer of the Future"—It flies along on a single steel cable at 200 miles an hour. A dream of to-morrow, based on facts of to-day.

Recent Developments in New York's subway system.

A Page of Electrical Summer-time Comforts.

Diamonds and Rubies Made to Order—A tale of the Electric Furnace Coupled to Modern Industry, by George Holmes.

The Spectroscope and How to Build One—written by an expert for beginners in the art of spectroscopy.

"Developments in Telephotography," by L. J. Leishman.

A Water Jet Blast Apparatus, by Prof. Herbert E. Metcalf.

New Radio graph chart which solves all calculations in wave-length, inductance and capacity, by E. M. Tingley.

"Gaseous Nebulae"—Part II of Popular Astronomy, by Isobel M. Lewis.

The Phenomena of Electrical Conduction in Gases. Part IV Why Ions Disappear, by Rogers D. Rusk, M. A.

The Design and Use of the Wavemeter—Part IV, by Morton W. Sterns.

Kenotron Rectifiers Stop Smoke.

Harmonics—Part II, by Prof. F. E. Austin.

When Blucher was standing on the London Tower looking over the vast city he exclaimed: "What plunder!" A German aviator flying over New York would exclaim: "What an opportunity for ruthlessness!" There are hundreds of targets here that would prove almost impossible to miss for the attacking aeroplanes; New York even at night lends itself extraordinarily well towards such an exploit. If you have ever stood on a tall building and looked over New York on a dark night, you will have found that it is never absolutely dark, the two rivers always providing a certain illumination, and the attacking aviator would find it difficult to miss his objects. There are, first of all, the hundreds of docks, the bridges across the East River, the railroad stations and numerous other points so large that a skilled aviator simply could not fail to hit his objectives when flying low. And we have no aerial defenses at the present time worth speaking about. We have heard about anti-aircraft guns being emplaced, but we have seen none so far. We have not a large defending aeroplane fleet as yet, and unless we organize one soon, we will be practically helpless against an aerial invasion. One remedy lies of course in having defending aeroplanes stationed about Long Island, who could give battle to the invaders as soon as they are sighted. This we consider of paramount importance, and we will in time no doubt have such a defense. It certainly is urgently needed.

It goes without saying that after the enemy aviator has accomplished his dastardly mission of bombing New York, it would be rather a difficult matter for him to get back to his submarine; nor is this at all necessary. If an aviator were chosen who could speak English well and who had been in America before, by means of his map, he could readily land his machine during the evening in a lonely spot on Long Island or somewhere up State where there exist large stretches of uninhabited land and where there are no houses or farms for miles. If he brought his machine down, which could be readily accomplished by volplaning down, he could make a practically noiseless descent. Then, if he wore civilian clothes, it would be a ridiculously simple matter for him to lose himself in one of the nearby cities. Of course this would necessitate abandoning his aeroplane, which, however, in an undertaking of this sort is a small matter. The Germans know very well that in a mission of this sort they must expect material losses as well as losses of life.

That some people do not consider an aerial bombardment of New York impossible, is best proven by the fact that any insurance man will tell you that millions of insurance has been taken out in New York recently against aerial bombardment. Nearly all of the large downtown buildings are carrying bombardment insurance at present.

The writer desires to advance an idea here, which, while it may not be an all-cure, might certainly prove to be an important factor if a raid is ever planned upon our cities.

His idea is to throw a cordon of sensitive submerged microphone buoys about the port of New York, our illustration showing the idea graphically. Anchored buoys, one or two miles apart, each containing a sensitive transmitter, are disposed in a half-circle off the shores of Long Island over a radius of say fifty or more miles; each buoy to be connected by cable to a central station which might be the Brooklyn Navy Yard. Three to five hundred of such buoys would effectively help us to listen in for submarines at the cen-

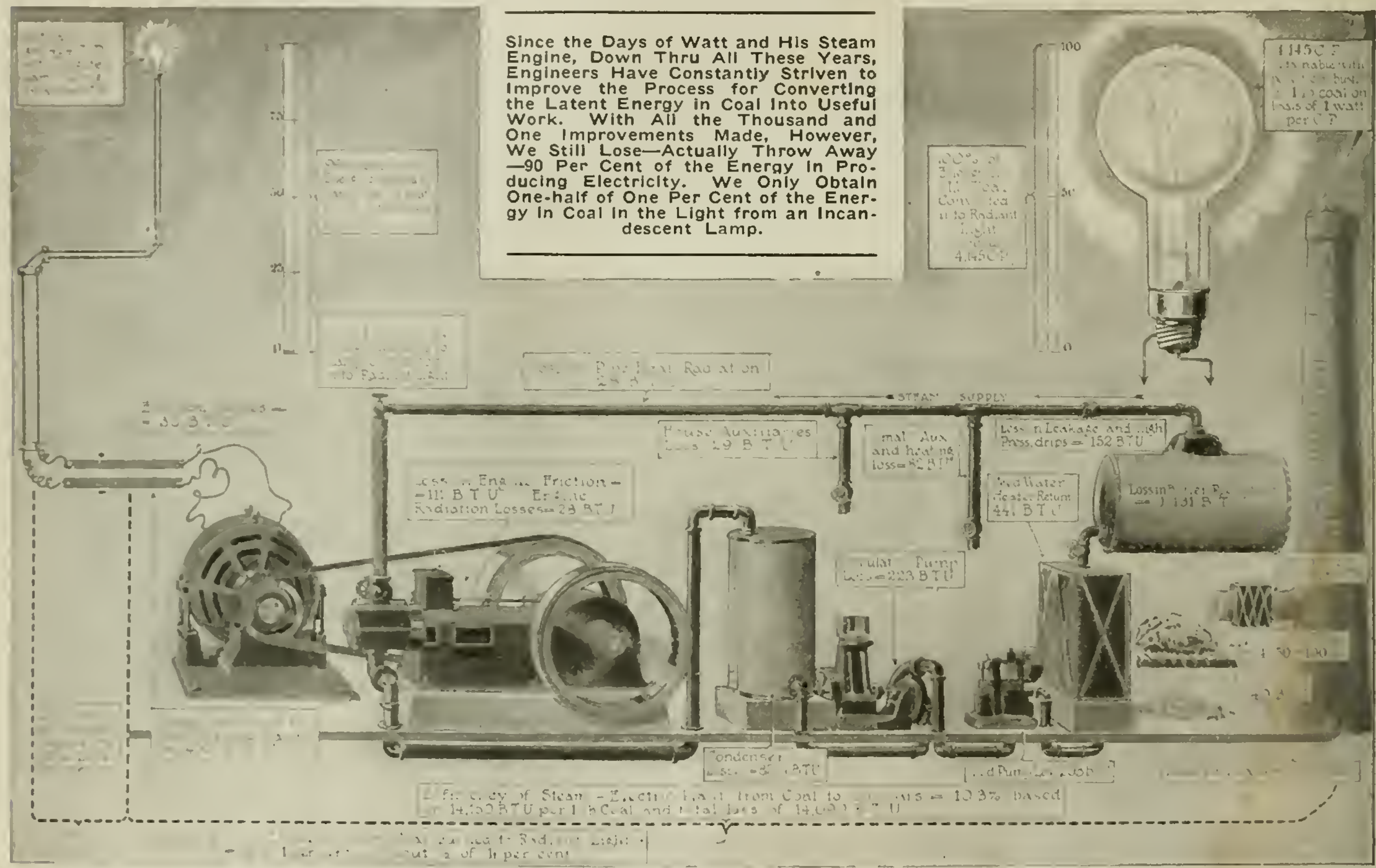
(*Continued on page* 192)

The Story of A Pound of Coal

Explaining the enormous losses occurring when a pound of coal is burned under a boiler, the steam generated used to run a steam engine, and this in turn caused to drive a dynamo supplying electricity for lighting

DID you ever stop to consider how much of the energy present in a pound of coal is actually converted into electrical energy, even in the best power plants of to-day? In a few words it is this—that out of every pound of coal burned in a steam boiler in an electric power station we only succeed in converting about *one-half of one per cent* of the total energy in that pound of coal into radiant light! The average person believes that in this so-called "electrical age" we have reached well-nigh perfection, but the above figure illustrates vividly that the electrical and steam engineers have many problems yet in front of them before anything like real efficiency is attained in converting the energy in coal to *electric light,* or for that matter into *electrical energy* with which to feed the lamps and other apparatus. For the largest and most highly developed steam-electric plants of to-day do not realize an over-all efficiency of much above *ten per cent.*

This figure of ten per cent represents the ratio between the coal burned in the boilers and the current delivered by the dynamos to the bus-bars, and shows that what most persons believe to be a wonderful and highly efficient electric power generating station is really throwing away about 90 per cent of the energy in the coal it buys. A modern water-power electric generating station may show a gross efficiency of as high as 56 per cent; therefore there is something radically wrong with our coal-burning methods, beyond the shadow of a doubt. Several well-known inventors have ventured to design a different type of apparatus for developing electrical energy direct from coal, but so far no commercially successful method has been perfected. Even Edison has tried his hand at perfecting such a machine, but so far we have not advanced beyond the well-known boiler and fire-box stage in our commercial utilization of the energy in coal.



Since the Days of Watt and His Steam Engine, Down Thru All These Years, Engineers Have Constantly Striven to Improve the Process for Converting the Latent Energy in Coal Into Useful Work. With All the Thousand and One Improvements Made, However, We Still Lose—Actually Throw Away —90 Per Cent of the Energy in Producing Electricity. We Only Obtain One-half of One Per Cent of the Energy in Coal in the Light from an Incandescent Lamp.

Copyright by E. P. Co., 1918

Therefore it is of interest to study this important subject a little and to find out where this enormous loss takes place. The accompanying illustrations show in a graphic manner just where these losses occur in each part of the system of a modern steam-electric plant. The various losses and efficiencies are taken from a report made in the transactions of the *American Institute of Electrical Engineers* by a well-known electrical engineer, Mr. H. G. Stott, and represent the efficiency of a large steam-electric plant. Some of the large present-day plants of this type obtain a slightly higher over-all efficiency than the one here cited. For instance, the Interboro Rapid Transit Company's plant in New York City showing a gross efficiency between coal burned and electricity developed, of about 12 per cent.

Let us now resume the discussion of the present steam-electric plant here illustrated. In looking at the illustration from right to left, keep in mind the energy in a pound of coal at the start, *viz.,* 14,150 B. T. U. (British thermal units. One B. T. U. is the amount of heat required to raise the temperature of 1 pound of pure water 1 degree Fahrenheit, at or near its maximum density, 39.1 degrees Fahrenheit. One B. T. U. is also equivalent to 778 foot pounds of energy; or 1 B. T. U. per hour = .000293 kilowatt-hour, also 1000 B. T. U. per hour = .293 K.W. hour). Having this quantity in mind the per cent loss in each apparatus is readily judged as we progress from right to left or reference to the following table prepared by Mr. Stott gives these percentages directly.

Thus we see where the energy in the pound of coal goes to before it finally reaches the switch-board bus-bars. In other words, starting with 100 per cent of energy in the coal when placed in the fire-box, we eventually throw away nearly 90 per cent of this energy, or to be exact 89.7 per cent, and deliver to the electrical system only 10.3 per cent of the power we started with, when we lighted the fire in the boiler.

If we operate electric motors from this electrical energy we fare quite well, as the motor has an efficiency of from 80 to 90 per cent or more, depending upon the size. That is, the motor converts say 90 per cent of the electrical energy put into it into mechanical power at the pulley. But in converting the electrical energy into radiant light we find that the most efficient of all incandescent filament lamps—the tungsten lamp—only realizes about 5 per cent efficiency, and requires about 1 *watt per candle-*

(Continued on page 198)

CUTTING 260 LAYERS OF CLOTH AT ONCE.

The garment cutting department of the Atlantic division of the Red Cross has its own little trials. Its particular job is to supply with garments cut out and assembled all the Red Cross chapters in New Jersey, New York and Connecticut as fast as those chapters send in calls for materials. And that is no easy task.

The amount of work required to keep up with the demand is enormous. Recently, in one week, more than 65,000 yards of material were cut into 1,600 dozen garments. To accomplish this the Red Cross has turned itself into a factory, and highly trained workers manipulating the most efficient kinds of machines make that output possible.

Between the work-room partitions are tables ninety feet long, over which on trolleys suspended from the ceiling run various electric machines. One of them is for spreading the material, one for making stencils as long as the table and another for actual cutting.

This last has to be guided with tireless care. It is fitted with a revolving knife razor so sharp that it will cut thru 260 layers of heavy material as easily as thru one. A single slip, therefore, on the worker's part, an instant's inattention, would be a costly thing.

The stenciling machines, which have little wheels with red hot points for burning holes in paper, are time savers. In order that there shall be the least possible waste of material the patterns have to be fitted into each other with the intricacy of a clever picture puzzle. To do this down the length of a ninety foot table takes an expert worker over four hours, where once a stencil has been cut an untrained person can mark the same amount of material in fifteen minutes.

The department, which has been in operation only a short time, has until lately confined itself to cutting hospital garments. Recently for the first time it undertook refugee garments as well. After devoting its energies exclusively to these for six days, it had on hand a sufficient stock of garments of nineteen varieties and forty-seven sizes to meet any orders which the chapters may send in.

The Cutting Division of the Red Cross Does Its Work by Electrical Machinery. After the Pattern of the Garment Is Stencilled Many Thicknesses of Cloth Are Cut at Once with Motor-Driven Cutters of the Type Here Shown.

MECHANICAL EQUIVALENT OF LIGHT.

A mathematical equation has been obtained by the U. S. Bureau of Standards for the visibility curve of the average eye. This equation was combined with Planck's equation of spectral radiation of a black body. Using the radiation constants of a black body and its brightness at various temperatures, it was possible to obtain the luminous equivalent of radiation or the so-called mechanical equivalent of light.

Independent checks of this constant were obtained by measurements upon an incandescent lamp of known candle-power, using a special physical photometer. The data obtained by various methods indicate that the mechanical equivalent of light is of the order of 1 lumen = 0.0016 watt of luminous flux of maximum visibility, or 1 watt = 49 candles.

These data are of much use to-day.

ELECTRIC STREET INDICATOR FOR TROLLEYS.

Ever Listen in Wonder to the Jargon Handed Out by Some of Our Trolley Conductors and Go About Six Blocks Past Your Street? This New Electric Street Indicator Promises to Solve All These Troubles.

Possibly there is no other invention in the realm of electro-mechanics that has received so much attention from inventors in the past ten years as that involving some form of street and station indicator adapted for use on trolley or interurban railway cars. Altho hundreds of such schemes, including everything from wonderful talking machine arrangements up to constantly changing signs, seem to have been thought of by the conscientious inventors striving to solve the problem, but very few of these automatic street announcer schemes have been tried out and few, if any, have found favor with the trolley and railway concerns at all, so it seems.

However, the accompanying patented arrangement recently perfected by Mr. John O. Lough seems to have considerable merit. The invention comprises a suitable enclosure cabinet, inside of which there is supported a revolvable drum on the perifery of which there are suspended pivotally a large number of signs, each of which is labeled progressively with the street numbers for a given car route. Just after passing each street an auxiliary electric circuit is closed which operates an electro-magnet placed within the announcer cabinet, this magnet actuating a set of pawls arranged in the manner shown in the drawing herewith. At each impulse of the electro-magnet and pawl system, the drum carrying the various street signs is moved around a short distance, just sufficient to bring the next street sign in position before the opening in the cabinet. An electric bell can be arranged to signal each change of the announcer so that passengers will pay proper attention to the device, altho once it is installed a short time, patrons will soon become accustomed to it. We believe Mr. Lough deserves a vote of thanks from a long suffering public, as all that we can hope to learn concerning the name of the next street announced at present is a conglomeration of vowels and consonants that sounds like—BLLWXY!?X.

"Violet rays," i.e., the discharge which takes place in a vacuum when the bulb in question is connected to a high frequency coil, can be deflected by means of an electromagnet.

An Electric "Movie" for Show-Windows

A new type of moving picture machine for office, convention and show window has been brought out by a New York concern. This machine displays pictures which can be readily seen in broad daylight, as well as by night. Its operation is entirely automatic in all its functions. After the reel is projected it is automatically rewound and then displayed again, so that after the machine is arranged and started it will continuously operate for an indefinite period without any further attention.

The outfit consists of two separate parts, the moving picture machine and miniature theater in which the pictures are displayed. The moving picture machine is operated by a standard type universal motor, which will operate on either direct or alternating current. Two horizontal discs carry the film which passes in one direction for projection and in the opposite direction for rewinding.

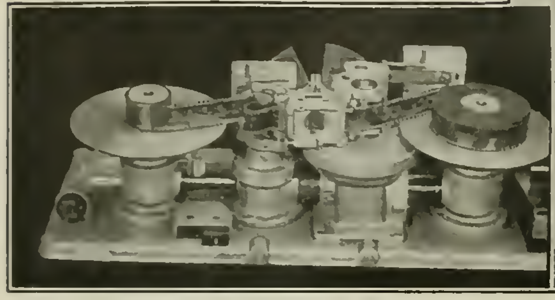
A 250-watt Mazda stereopticon lamp, with concentrated filament, furnishes the light, which is automatically extinguished when the machine stops and during the process of rewinding.

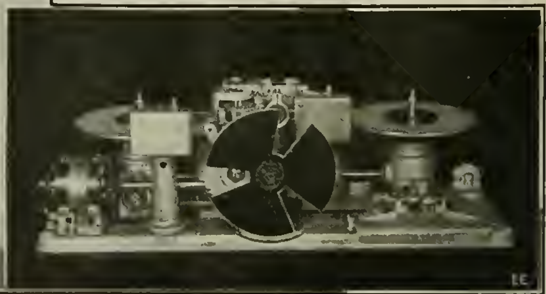
The machine is equipt with two automatic safety switches, which are provided for in case the film breaks, in which event the machine stops and the light goes out, if this occurs while projecting; in case it happens while rewinding, the machine simply stops, the light being out.

All parts of the machine are made from an aluminum composition, so that it weighs but thirty-five pounds. There is a dust-proof and soundproof cover provided which acts as a carrier for the machine, as well as a cover.

The moving picture projector is placed about a foot from the miniature theater so that the light enters an aperture in the base; here it strikes a mirror set at an angle of 45 degrees, and is reflected upwards onto a screen, set on what would be termed a stage. Another 45-degree mirror reflects an image of the screen, making the picture appear to the audience to come from a screen on the rear wall of the theater.

Standard non-inflammable films in lengths of 50 to 500 feet can be exhibited. The outfit draws 2½ amperes and is approved by the National Board of Fire Underwriters.





At Last—a Real Practical Show-Window "Movie" Machine. It Can be Set In Any Show-Window and Works Entirely Automatically. It Is Operated by an Electric Motor. It Uses Non-Inflammable Films Up to 500 Feet In Length. The Lamp Used Is a 250 Watt Incandescent Type. It Rewinds the Film Automatically. Center Photo Shows "Movie" as it Appears to the Sidewalk Audience.

THOSE "ODD" ELECTRICAL PHOTOS.

The accompanying photo shows a really novel electrical effect—the kind we are after and stand ready to pay $1.00 cash each for. Say, readers, we really wonder if you have ever read the notice publisht on the title page of the "Question Box" in every issue for the past six months. This notice to all readers, whether regular subscribers or not, says that $1.00 will be paid for any photo we can use—but they should be "odd ones," like that below.

Now, readers, and there are several hundred thousand of you, for the love of Horse-thief Pete, get out that kodak or plate camera. Dust her off and go shooting for that "odd photo." We know it's there, but as we can't travel all over the United States and thru foreign climes to ferret out these interesting subjects, we put it up to you to get these photographs for us.

The present photo is a beautiful one and it shows the "ladder sparks" produced by the amateur photographer — Mr. Kenneth Strickfaden's — eighteen-inch spark coil in full activity. Mr. Strickfaden took this fine photo, the original being of ordinary pocket kodak size, or 3¼ by 5¼ inches.

No, Oswald, This Is Not a Banana Spider's Web, Nor Sister's Knitting Wool Being Disentangled—It's Just a "Good" Photo of an 18-Inch Spark "Ladder." We Want More Such Photos!!!

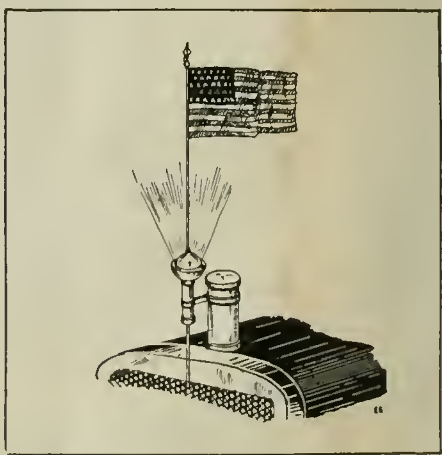
WASHINGTON STATE COLLEGE TO HAVE SIGNAL CLASSES.

Washington State College, Pullman, Wash., will heed the call of the government for 15,000 trained men for the signal corps and will attempt to provide between 50 and 100 men qualified for this service in as short a space of time as is possible. Classes in signal corps work will be started immediately. Training will be given in the international wireless code, a speed of 20 words a minute in sending or receiving being required before the completion of the course. The code to be taught is used thruout the signal corps service in wireless, wigwag and buzzer signaling.

The United States Government buys about 2,000,000 incandescent globes yearly.

LIGHTING THE AUTO RADIATOR FLAG.

An electric lamp for illuminating a radiator flag, which may also be used as a portable inspection lamp, has been developed by a New York concern. The outfit includes a silk flag, a silver-plated parabolic reflector and a rubber-finished rolled steel bracket. It can be operated at small cost from the automobile lighting and starting battery. Where no storage battery is available, dry cells can be used.



To be Up-to-date You Must Have an Illuminated, Waving Flag on Your Auto. It Takes Current From the Car Battery or Dry Cells.

GREAT WASTE OF HYDRO-ELECTRIC ENERGY.

Enough hydro-electric energy is running to waste to equal the daily labor of 1,800,000,000 men or thirty times our adult population, according to Secretary of Interior Franklin K. Lane.

Milestones in the Life of Thomas A. Edison

THOMAS A. EDISON, leader in American scientific thought, has accomplisht so many wonders in his lifetime that to enumerate them would seem to require a lengthy article, but the following tabloid outline of the scientific milestones in his wonderful career give a succinct and comprehensive survey of his activities. This paper was presented before a meeting of the San Francisco Development League by Frank D. Fagan.

1847.

Born February 11th, at Milan, Ohio.

1857.

Started chemical laboratory in cellar of his home.

1859.

Became newsboy and "candy butcher" on trains of Grand Trunk Railway, running between Port Huron and Detroit.

1862.

Printed and publisht a newspaper, *The Weekly Herald,* on the train. The first newspaper ever printed on a moving train.

1862.

Saved from death young son of J. U. Mackenzie, station agent of Mount Clemens, Mich. In gratitude, the father taught Edison telegraphy.

1863.

Spent nearly five arduous years as a telegraph operator in various cities of the Central Western States, always studying and experimenting to improve the apparatus.

1868.

Entered office of Western Union in Boston as operator.

1868.

Made his first patent invention, electrical vote recorder. The application for patent was signed October 11, 1868.

1869.

Landed in New York City from Boston boat, poor and in debt. Shortly afterward, while looking for work, was in operating room of Gold & Stock Telegraph Company when apparatus broke down. No one but Edison could fix it, and he was given job as superintendent at $300 a month.

1870.

Received his first money for inventions, the stock ticker, $40,000. Opened manufacturing shop in Newark, where he made stock tickers, etc.

1871.

Assisted Sholes, the inventor of the typewriter, to make the first successful working model.

1872 to 1876.

Worked on and completed many inventions, including motograph, automatic telegraph systems, duplex, quadruplex, sextuplex and multiplex telegraph systems.

1876 to 1877.

Invented the carbon telephone transmitter, which made telephony a commercial art, and which was combined in 1914 with his later invention, the phonograph, to form the telescribe.

1877.

Invented the phonograph. Patent was issued by United States Patent Office within two months after application, without a single reference.

1879.

Invented incandescent electric lamp. The invention was perfected October 21, 1879, on which day the first lamp embodying the principles of the modern incandescent lamp was put in circuit and maintained its incandescence for over 40 hours.

1879.

Invented radical improvements in construction of dynamo-electric machines, making them suitable for generators for systems of distribution of current for light, heat and power.

Photo © by Central News Photo Service

A Recent Photo of America's Foremost Electrical Scientist, Thomas A. Edison, Who Is Working for the Government on New Inventions of Great Importance.

1881.

Established first commercial incandescent lamp factory at Harrison, N. J.

1880 to 1882.

Invented and installed life-sized electric railway for freight and passengers at Menlo Park, N. J.

1882.

September 4, commenced operation of first commercial central station in New York City for distribution of electric current for light, power and heat.

1891.

Invented the motion picture camera. By the invention of this mechanism, with the continuous tape-like film originated by Edison, it became possible to take and reproduce motion pictures as we have them at this day.

1900 to 1910.

This period covers the work resulting in the invention of the Edison Alkaline Storage Battery, and its commercial introduction.

1914.

Edison, being the largest individual user in the United States of carbolic acid (for making phonograph records), found himself in danger of being compelled to close his factory by reason of the embargo placed on exportation by England and Germany, the sources of supply, carbolic acid being used in making explosives. Edison devised a plan for making carbolic acid synthetically, set gangs of men working 24 hours a day to build a plant, and on the 18th day was making the acid. Within four weeks plant could turn out a ton a day.

1914.

On the night of December 9th, Edison's

(*Continued on page* 194)

NEW MONUMENT MARKS PLACE WHERE TELEPHONE WAS CONCEIVED.

Dr. Alexander Graham Bell, inventor of the telephone, tells us that Brantford, Ontario, Canada, is right in claiming the invention of the telephone. The invention, according to Dr. Bell, was conceived in Brantford in 1874, forty-four years ago, and born in Boston in 1875. Dr. Bell was present at the unveiling ceremony as well as leading telephone men from the United States and Canada. The great achievement of the telephone invention by Prof. Bell has thus been commemorated by the erection of a magnificent granite and bronze memorial, which is located in one of the city's parks.

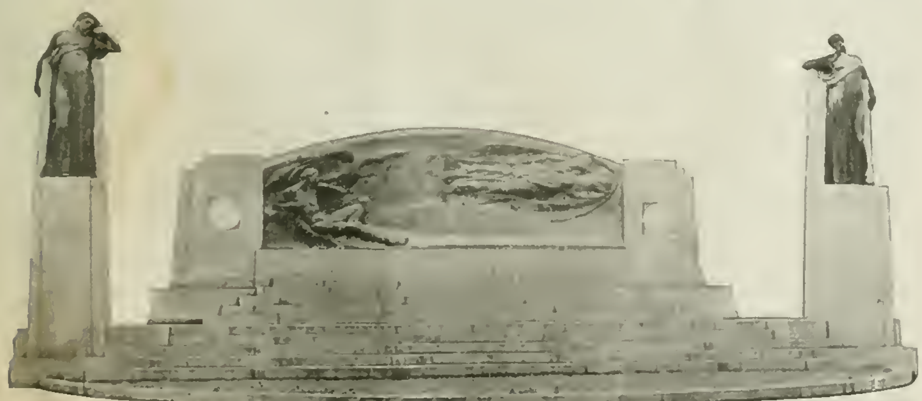
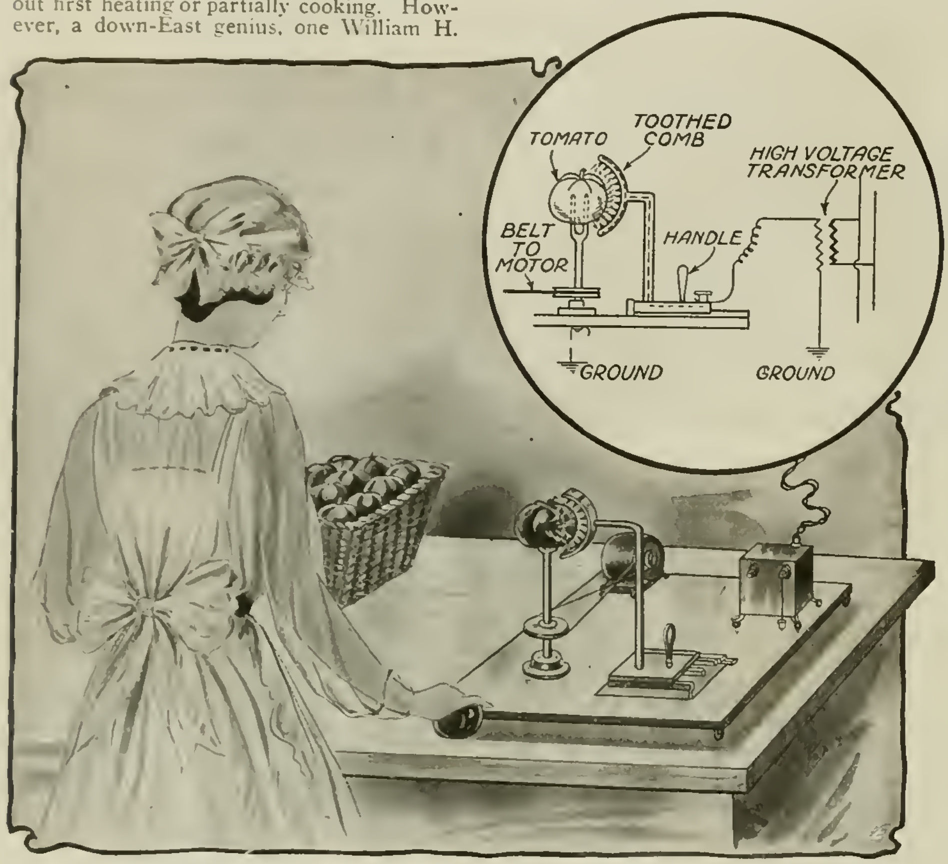


Photo Telephone News

It Was at Brantford, Ontario, That the Telephone Was Conceived by Alexander Graham Bell. This Beautiful Monument Now Commemorates the Achievement.

Peeling Tomatoes by Electricity and Reclaiming Waste

In the operation of canning tomatoes and other vegetables it has hitherto been practically impossible to remove the skins without first heating or partially cooking. However, a down-East genius, one William H. Chapman, of Portland, Maine, has found that if the skin of the tomato is punctured by electric sparks sufficiently near together, the effect will be to form small holes in the skin which loosen it from the pulp, so that it may be readily peeled or stript off. He has obtained a U. S. patent on the scheme. The heat from the spark apparently has the effect, besides puncturing holes in the skin, to expand the air inside of the skin where the spark passes thru and so detach the skin from the pulp.



The Tomato Promises to Be One of the Leading Factors in Food Conservation. This Electric Peeler Removes Their Skins Quickly and Government Experts Have Found a Use for All Skins and Pulpings.

A comb conductor charged with a high voltage alternating electricity is located adjacent to the tomato and the apparatus is so formed and manipulated that all portions of the skin are presented to the discharging points.

In the apparatus illustrated for carrying out the process in a simple manner, the tomato is stuck on a forked support or spindle, journaled in the base of the device and slowly rotated by a suitable pulley and belt connected with an electric motor.

As here shown, the comb is connected with an alternating current line with a commercial current of 110 volts connected with the primary of a transformer. Thru the transformer, the voltage is raised to about 12,000 volts, capable of producing a spark of nearly one-half inch in length. The connection from the conductor to the transformer is made thru the carriage by means of a wire. A handle is provided for sliding the carriage back and forth to the tomato being operated upon. The holder on which the tomato is held is formed of metal or other conductor and is thoroly connected to earth.

The number of alternations of the usual commercial circuit are 60 per second and the sparks will be emitted from each of the points substantially at this rate. The tomato may thus be rotated with considerable speed and the skin will be thoroly perforated with holes. In applying this process to a canning factory, much more elaborate and rapid acting mechanism would be used, but that illustrated is perfectly capable of carrying out the process.

While this process is primarily designed to be used for tomatoes, it is capable of being used with any fruits or vegetables with thin, non-conducting skins, as plums, apples, peaches, corn, etc. The body of the tomato is not affected by the current used.

But most important of all, a recent bulletin of the U. S. Department of Agriculture brings the fact that vast quantities of tomato refuse accumulating each year at tomato-pulping factories can be reduced to two products—viz., fixt oil and meal—both of which may be made commercially useful. The oil from the seeds is suitable for use as an edible oil or as a soap oil, and by proper treatment can be made useful as a drying oil for paint and varnish. The meal has valuable qualities as stock feed. The department urges the establishment of reducing plants and the adoption of a co-operative plan of manufacture in the regions where tomatoes are extensively used to make catsups and soups, the seeds and skins being at present discarded as useless. The utilization of tomato wastes seems to have made much more progress in Italy than elsewhere.

A TROPICAL LINE PARTY.

Seeing in the December issue a photo of a telegraph line party in the far North, I thought that a photo of a line party in the tropics might be of sufficient interest to send to you.

The boys shown in the picture are recruited from their native villages in the Territory of Papua, and sign to work for the Government for three years at the rate of 10 shillings per month and found ($2.50), and are placed under the charge of a white lineman who instructs them in the various arts of "slinging lines"; from there they pass to fitting instruments, locating faults, etc.

After the three years are up they are sent back to their homes for a spell and, should they desire they sign again for three years, this time as operators, their wages being raised to 15 shillings a month and found.

The telephone exchange is a magneto service of a hundred lines, with several long-distance lines to plantations, the longest being 34 miles from Port Moresby.

The boys (Meros) are taught English at the Mission school during their second term; otherwise to ask for, say call 26, would sound something like this—"Rua-Huey—Toura Toi.—JOHN J. BOILEAU.

A Tropical Telephone Wiring Party, Composed of Native Boys, Who Work Three Years for Their Government At the Rate of $2.50 Per Month!

Make Way for the Lady Engineers

IT'S just a bit difficult to say who the first lady engineer was. The number of women—other than typists, stenographers and clerks—employed in the engineering department of one of the largest electrical manufacturing companies has been gradually increasing in the past four years. Most of these young women who have entered the realm of real, applied engineering were college graduates to whom school teaching was evidently not the one and only resort. All of them were at first assigned to one group. Requests for translating, reference work and computations were made on this group. Later, when the telephone transmission branch started talking in terms of *impedance* instead of *resistance*, and doing other queer things, the demand for computresses in that particular branch became so great that several girls were definitely assigned to transmission work as calculators. From this beginning it was easy enough to present the girls to the various measuring devices.

Girls were tried at the calling end of telephone transmission tests, but the voice strain was found to be too great, so now their activities in this particular field are limited to listening—listening to nursery rhymes and the like for hours upon hours!

In addition to computing and making electrical measurements and transmission tests, girls are also employed on drafting and on follow-up work on jobs placed in the Model Shop.

The other laboratories of this electric company were quick to realize the value of women for certain kinds of work, so they, too, began to cast around for suitable representatives of the female of the species. In the Physical Laboratory the experimental work on telephone switchboard lamps and on filaments in general required deft fingers as well as agile brains. Here, then, was an opportunity not only for girls with some technical training, but also for those with skill in light manufacturing processes. Thus we see the entrance of girls into the realm of the breakdown test, the life test, the humidity test, and dozens of other important and exacting tests.

Of course, calculators are as much in demand in the Physical Laboratory as anywhere else—so the demand for mathematicians went up a few notches more.

Who Said the Women do Not Take Up Such Studies as Electrical Engineering? They're All Wrong, for Here Is Evidence to Show That Women Are Holding Their Own in a Large Research Laboratory.

Recently there has been a great demand for special condensers and fuses which, for various reasons, must be manufactured under laboratory conditions. This work does not of necessity call for operatives with more than average education, but it does mean the presence in the laboratory of a fairly large number of women. If any of them show special aptitude or inclination, it is a fairly easy problem to acquaint them with the workings of the simpler measuring devices and to instruct them in the making of various mechanical tests on apparatus. It has been found that women have a distinct aptitude for mathematical and engineering processes. They operate Wheatstone bridges, planimeters and slide rules with speed and precision.—*Photos Western Electric Co.*

Here Again We Have the Women Technicians in the Chemical Laboratory of One of the Largest Electrical Concerns. As the War Goes on We May Expect to See More and More Women in Engineering Lines.

ELECTRIC ORANGES.

Prof. J. A. Fleming, in a lecture at the Royal Institution, London, England, to a juvenile audience, said that not many boys and girls knew that when they cut an orange with a steel knife and a silver fork a current of electricity past thru their hands. The acid in the orange acted on the steel, and the orange acted as a voltaic cell.

X-RAY DETECTS TUBERCULOSIS.

Electricity is playing an ever increasing part in the examination of troops for medical defects. The X-ray has been employed recently in determining whether certain New York troops have tuberculosis. Of the first 600 men examined by this means twenty-two were found to be so infected as to disqualify them for military service.

An American Ace

AN unprecedented triumph! And rightfully may it be said so, for with a smack of the old melodrama, Biff! Bang! of shot and shell this truly patriotic war play has arrived into its own.

with a crash and a bang buildings tumble down and with all the debris and plaster flying around, it might well be best to bring your own "dugout" and gas helmet with you.

It's Hard to Tell the Imitation Soldier from the Real One These Days, Especially When the Signal Corps Members of "An American Ace," a Recent Stage Success, Start Acting.

The play is centered about a number of thrilling scenic effects of which probably the most realistic is that where our boys go "over the top."

The story of the play is somewhat slow in action in the first part and this could stand a little speeding up. It is not until the second act that it really struck its stride and after that the action was fast and exciting.

James L. Crane was a thru and thru "pacifist" in the first part until, the wavering spark of patriotism answered the call and from then on he was out to get the "Hun."

Somewhere on the battleline the Germans abandon a Belgian village, leaving behind them desolation, destruction and two spies "He" and "She" to communicate information that will enable them (the Germans) to "gas" the Americans without warning.

The Americans arrive and take the village but are rather suspicious of the two spies and when the man is seen telephoning information to the enemy by a little "Belgian Miss," the heroine, the female spy gives an alarm so as to ward off suspicion from herself and incidently enable her to carry on the nefarious work. The hero, who is now an "American Ace," naturally falls in love with the "little Miss" and a quaint courtship is interwoven amidst all the cannons' roar.

The villainess eventually meets her Waterloo and the final scene shows the lovers united in each others' arms atop a church tower, while down below the Americans are driving back the "Boches" with fixt bayonets.

Chief amongst the thrillers is an exciting battle in the clouds when the "American Ace" goes up and downs three German planes. So realistically is this scene arranged that the spectators imagine themselves up in another plane looking on at the duels taking place. Another tense moment comes when the German planes bomb the town with aerial torpedoes, when

It is quite interesting to note the faithful military atmosphere that is truthfully kept, especially when the American boys take the town. Entering in a dignified and business-like manner they proceed to lay out plans, while the "Signal Corps" troops establish their lines of communication, switchboards, etc. A close-up view herewith shows the general staff and the chief officer issuing orders for the strengthening of various portions of the lines.

The true fire-works commence when the boys go "over the top;" then Cain lets loose and by the amount of deafening reports it sounds like the Great Spring Drive transplanted to the United States. To your "dugouts," boys, when this big thrill comes off!! Nevertheless the audience took it in great shape and it was greeted with a storm of applause.

All of the members of the cast did well and special mention might be made of the excellent hero rôle as played by Mr. Crane, the equally admirable heroine, Miss Marion Coakley, who with her sweetness and charm is a "comer"; Miss Sue Mac Nanamy was a charming villainess.—George Holmes.

An electric magnet weighing only seven pounds that will lift fifteen times its own weight has recently been invented. It is intended for use in machine shops.

THE NEW YORK MEETING OF THE A. I. E. E.

The April meeting of the American Institute of Electrical Engineers was held on the evening of April twelfth and was attended by a large number of the engineering fraternity, amongst whom were several prominent persons, including many members in uniform who are doing their all for the U. S. A.

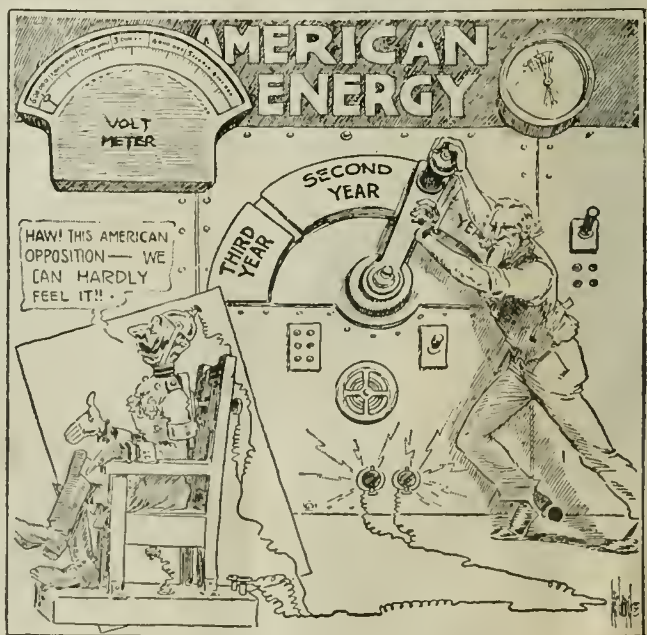
Two important papers were presented: "A physical Conception of the Operation of the Single-Phase Induction Motor," by B. G. Lamme, and "No-Load Conditions of Single-Phase Induction Motors and Phase Converters," by R. E. Hellmund.

Mr. Lamme read his own paper, which covered a new method of studying the actions of a single-phase induction motor, a method which he had found to be very convenient from an educational standpoint.

Starting with the assumption that a single-phase alternating magnetic field may be considered as being made up of two constant fields, each of half the peak value of the single-phase field and rotating at uniform speed in opposite directions, then if the single-phase flux distribution is of sine shape and varies sinusoidally in value, it may be replaced, or represented, by two sine-shaped fields of constant value rotating in opposite directions.

The full load conditions are next considered. A comparison is made between a two-motor unit, consisting of two similar poly-phase motors coupled together and connected for opposite rotation, and the straight single-phase induction motor. Several diagrams were shown, as well as some interesting curve charts. The paper contained a considerable amount of test data, which served to illustrate the principles and actions described in the paper.

Mr. Hellmund was unable to attend, much to the regret of those present, and his paper was read by Mr. A. M. Dudley. The paper showed methods and derived formulas for the determination of the fields, the stator and rotor magnetizing currents, and the tertiary voltages for phase-converters and single-phase induction motors at no-load. The treatment of the subject is uniformly based on fundamental laws. A number of different considerations are used for the various cases illustrated to assist in the solution of the problems; however, all are based on simple facts.

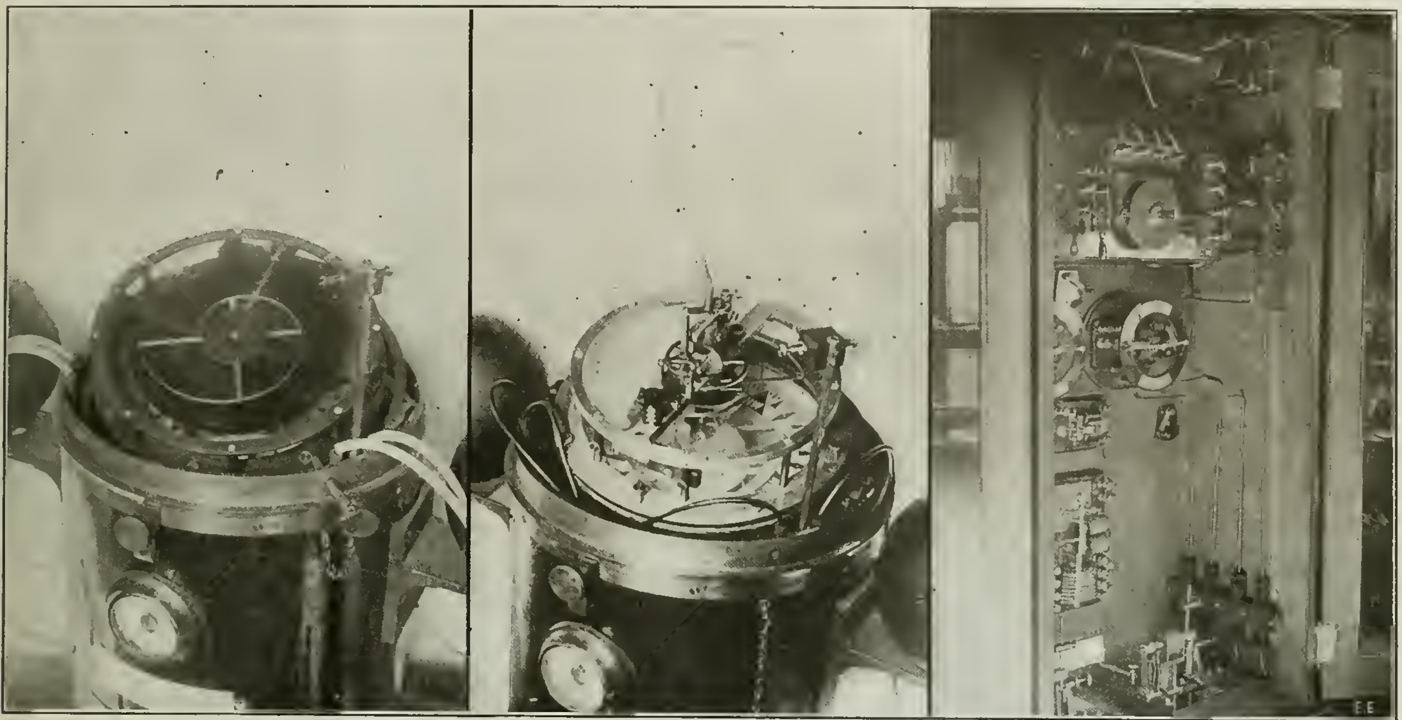


"Don't Be Impatient, Bill, You're Going to Feel It."
—Ireland in the Columbus Dispatch.

A New Electric Recording Compass

By EUGENE STAEGEMANN, Assoc. A. I. E. E.,—Prof. of Mathematics and Mechanics, Vocational High School, New Britain, Conn.

THE new electric-recording compass device, here illustrated, is one which nautical experts have proclaimed to be a great advancement in maritime appliances. This electric Recording Compass was invented by Dr. C. L. Jaeger of Mahwah, N. J.



Three Views of the Jaeger Electric Recording Compass, a Number of Which Are Being Built for the Navy Department.. At Left—The Recording Compass With Dial Removed; At Center—Compass Complete With Spark Recorder and Chart; Right—Electrical Instruments Used With Recording Compass.

Dr. Jaeger began his first series of experiments on his recording compass about 1885, in the days when the electrical experts of the world were classified in two ways—those who knew Ohm's Law and those who didn't. He jokingly attributes his endeavor to supply vessels with a device which would record a permanent record of the entire route covered, to the fact that the Nautilus, Jules Verne's master creation in *"Twenty Thousand Leagues Under the Sea,"* had every conceivable type of apparatus and appliance aboard except a *recording compass.* To remedy this serious defect he began the first experiments.

It is perhaps unnecessary to say that he encountered great opposition, but finally, after five years of ceaseless toil, in an attic, and great sacrifices a crude working model suitable only for descriptive purposes was completed.

A trial cruise was made from New York to Jamaica Island on board the S. S. Amelia, during which the instrument faithfully executed all the claims of its inventor.

Captain Jamison in command of the vessel was particularly gratified by the results. Charged with this encouragement, Dr. Jaeger endeavored to market the invention, but met with violent opposition, not on the part of the ship owners who appeared

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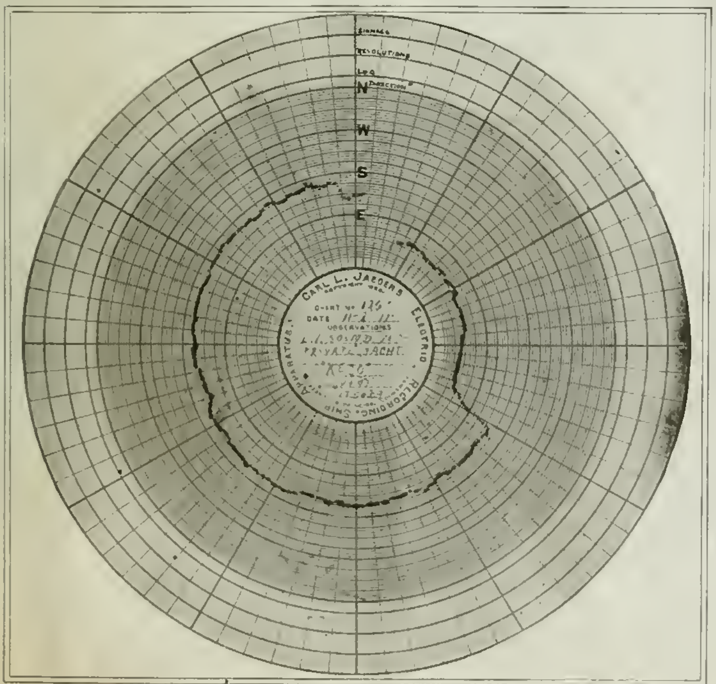
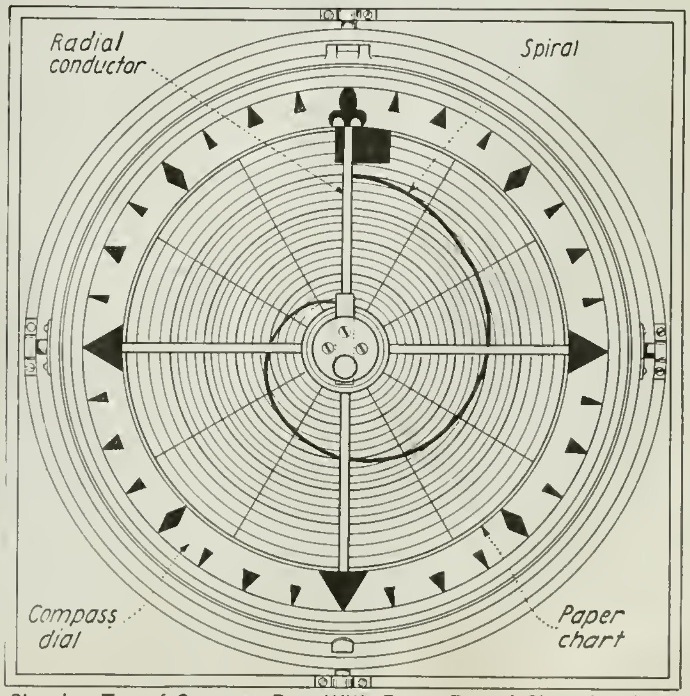


An Actual Compass Record of a Cruise Up Long Island Sound Taken On Board Dr. Jaeger's Yacht. Each Angular Division Represents a Time Period of One Hour.



Showing Top of Compass Box, With Paper Record Chart In Place, Also Spiral Electrode From Which Spark Jumps In Making Record. The Recording Is Thus Done Without Friction.

Radium Emanation in the Treatment of Disease

By GEORGE HOLMES, Assoc. A.I.E.E.

RAPID strides have been made during the last five years in the advancement of practically all branches of science. Especially is this true of Radium, in its various forms, and its application to relieve humanity of much of its suffering.

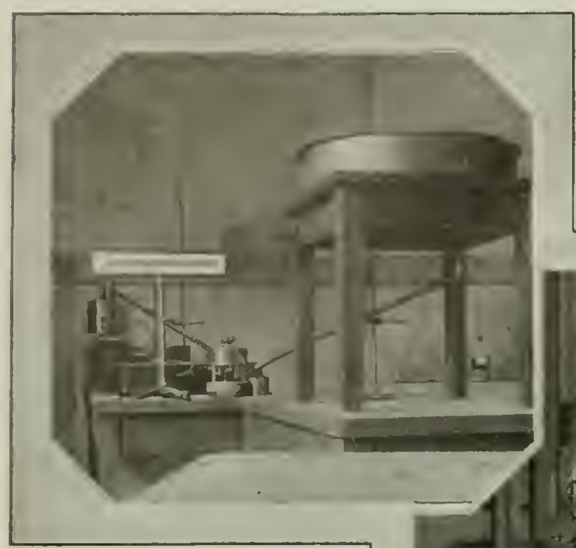


Fig. 5. (Above) Shows the Highly Sensitive Electrical Apparatus and Instruments Used in Measuring the Quantity of Radio-Active Substance in an Applicator.

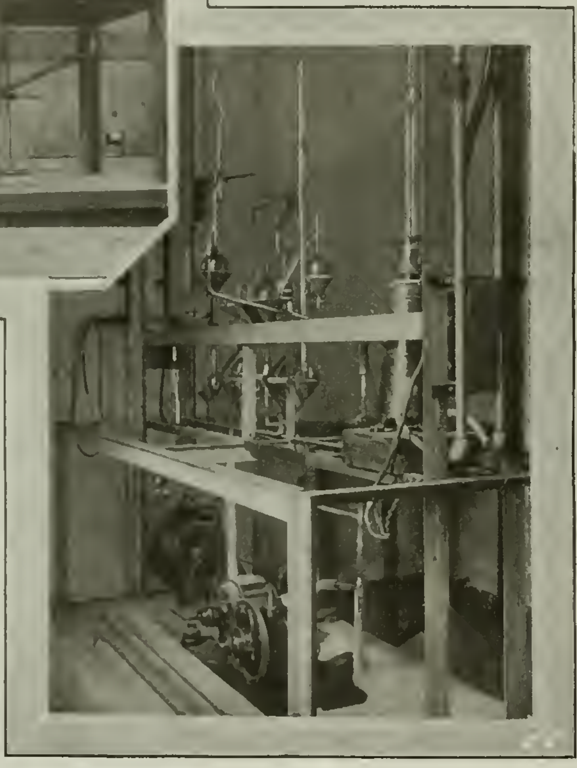


Fig. 1. (Below) Photograph Taken in New York Hospital, Showing the Elaborate All-Glass "Radium Emanation" Generating Apparatus Illustrated in Fig. 3.

Early in 1912, from information that reached the U. S. Bureau of Mines, it became evident that large quantities of valuable Radium bearing ore from Colorado was being exported to foreign countries for purposes of manufacture, and undoubtedly a part of the manufactured product was being reshipt to this country.

In view of the fact that the largest known supplies of Radium bearing ore in the world was centered in the States of Colorado and Utah and on public lands of the U S., the Bureau of Mines decided to investigate the prospect and to ascertain whether these valuable tracts could not be acquired by the U. S. and the Radium extracted under Government supervision, to be supplied at cost to the hospitals of the Army, Navy and Public Health Service.

At that time no appropriation for such work was available. However, the Bureau learned that Dr. Howard A. Kelly of Baltimore, Md., and Dr. James Douglas, of New York City, were deeply interested in the production of Radium for use in two hospitals with which they were closely associated. The suggestion was made that they form a Radium Institute, to work up the ore and keep the Radium for the use of our own people. The mines were inspected and after extensive preliminary surveys, the National Radium Institute was founded. The agreements being that the Institute was to receive the Radium from the owners of the mines on a 15 per cent royalty basis, with the stipulation that the Institute would return the uranium and vanadium contents of the ore to the company.

A considerable personnel was instituted at the radium plant and a number of large buildings erected and put in operation. The average capacity of the plant at present is about 3½ tons of ore per day, and a considerable amount of the element has been extracted up to the present time. Beyond any doubt, the amount of Radium in nature is exceedingly small. Therefore this fact, in itself, is an important factor bearing on its value today. Altho quicker and better processes are used for its extraction now than, say, four or five years ago its market value will not decrease to any extent.

To total amount of *Radium element* at present in the world extracted from the ore is said to be 61 grams of which amount 16 grams is held by various doctors and institutions in the United States. Dr. Howard Kelly of Baltimore has about 6 grams, the Memorial Hospital of New York has 3¼ grams, and the other 6¾ grams are distributed in the U. S. The remaining 45 grams are in various other countries.

It has been estimated that if all the Radio-active ores were mined they would not produce more than a total of 400 grams of refined Radium element; therefore the high cost of Radium—at present $120,000 a gram, or $120.00 a milli-gram.

Radium is a chemical element, belonging to the group of metals, but unlike most other elements, it is not **extraordinarily** stable. It transforms itself at a measurable rate into another substance called *Radium emanation*. The rate of transformation, is so slow, however, that about 1700 years would be required for half a given quantity of Radium to disappear.

The *emanation* is a chemically inert gas, and it, too, transforms itself into a third substance called *Radium A*, but this is not all. Radium A transforms itself into *Radium B*, and Radium B into *Radium C*, this forming a series or chain of substances all related to each other.

None of the above substances is a gas except the emanation Radium A; B and C deposit themselves on anything and everything that comes in contact with them, including the walls of the vessel that contain the emanation.

Radium may be used in the treatment of disease either in the form of *Radium salts* or *Radium emanation*, the therapeutic effects being identical.

This Radium emanation may be collected in glass tubes or metal containers, and used with appropriate screens, as Radium salts themselves, or dissolved in distilled water or in a weak saline (salt) solution, and administered by drinking or injection. Emanation applicators are often of the greatest value in treatment of malignant

Fig. 2. Showing the Relative Size of Silver Tube Containing "Radium Emanation" Used in Various Treatments of Cancerous Growths.

growths, as in them it is possible to concentrate the activity per unit area to a very high degree. For example, the 100 mg., tubes of *Radium sulfate* generally used, measure 4 cm. in length and 0.2 cm., in diameter. It is quite easy to make an emanation tube of equal activity measuring only 0.5 cm., in length by 0.05 cm., in diameter.

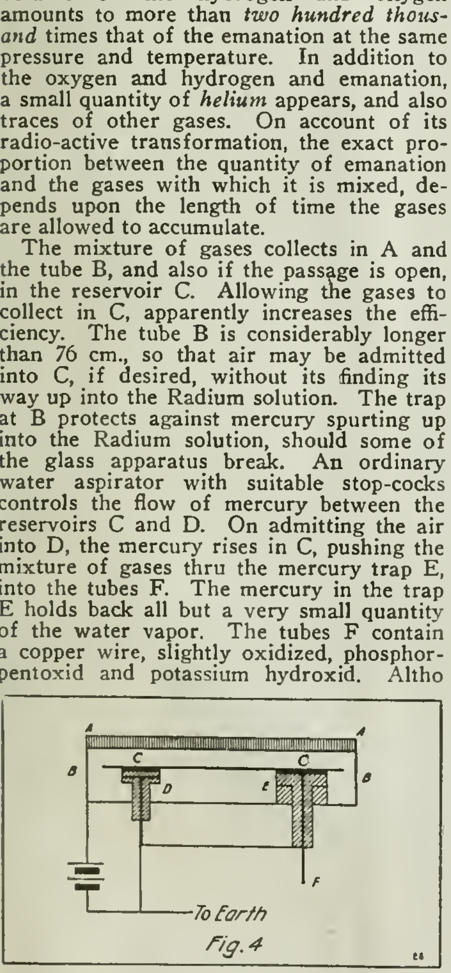
Such a tube can be enclosed in an iridium pointed platinum needle with walls of 0.3 mm., in thickness, thus forming a very small but extremely powerful apparatus for the treatment of nodules in tongue, palate, breast or other organs.

Radium emanation falls to half-strength in 3.85 days, losing 16 *per cent* of its initial activity during the first twenty-four hours. The duration of an exposure rarely exceeds twenty-four hours, and if it be decided to give a treatment for that time with a radium emanation applicator of say 100 mg., strength, the apparatus leaves the laboratory with an initial activity of 109 mg. 110 mg. At the end of 24 hours its activity will have fallen to 92 to 93 mg., so that its mean activity thruout that period will have been approximately that of 100 mg.

The general principle of the operation of the apparatus necessary to fill the small capillary tubes with the *Radium emanation* is as follows:

Fig. 3 represents the arrangement of the glass tubes and reservoirs. The bulb A contains the Radium salt dissolved in water. Radium in solution continually decomposes the water into hydrogen and oxygen, and at the same time transforms itself into the emanation, which is set free. The total volume of the hydrogen and oxygen amounts to more than *two hundred thousand* times that of the emanation at the same pressure and temperature. In addition to the oxygen and hydrogen and emanation, a small quantity of *helium* appears, and also traces of other gases. On account of its radio-active transformation, the exact proportion between the quantity of emanation and the gases with which it is mixed, depends upon the length of time the gases are allowed to accumulate.

The mixture of gases collects in A and the tube B, and also if the passage is open, in the reservoir C. Allowing the gases to collect in C, apparently increases the efficiency. The tube B is considerably longer than 76 cm., so that air may be admitted into C, if desired, without its finding its way up into the Radium solution. The trap at B protects against mercury spurting up into the Radium solution, should some of the glass apparatus break. An ordinary water aspirator with suitable stop-cocks controls the flow of mercury between the reservoirs C and D. On admitting the air into D, the mercury rises in C, pushing the mixture of gases thru the mercury trap E, into the tubes F. The mercury in the trap E holds back all but a very small quantity of the water vapor. The tubes F contain a copper wire, slightly oxidized, phosphorpentoxid and potassium hydroxid. Altho

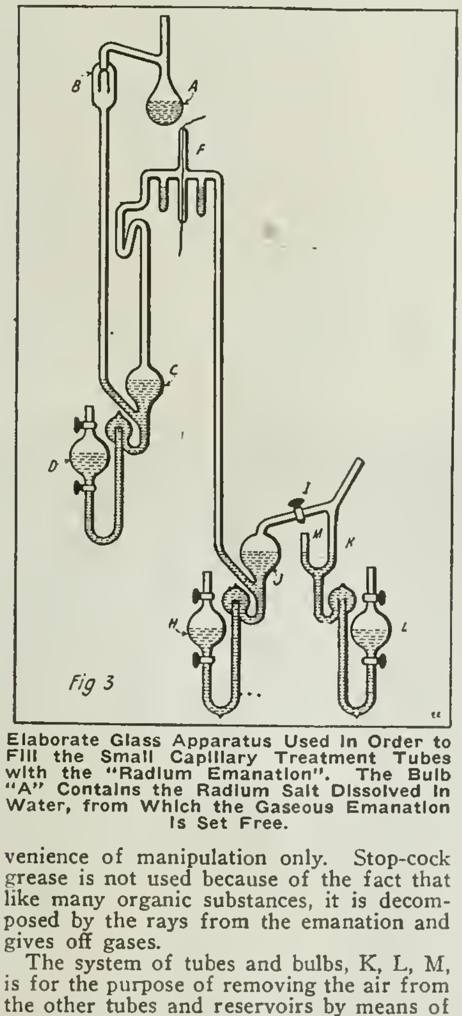


Simplified View of Electrical Method Used in Determining Accurately the Quantity of the Radio-Active Substance in an Applicator. It Is Used in Conjunction with a Sensitive Electrometer.

represented in the figure in a vertical position, the copper wire really lies horizontal. It is wound on a quartz rod supported by quartz feet, so that the wire does not touch the inner surface of the tube at any point. When heated red hot by an electric current of 5-10 amperes it rapidly combines the oxygen and hydrogen, the phosphorpentoxid absorbing the water vapor formed. A small amount of copper oxid on the wire is required, because the mixture of gases contains (at least at first) a quantity of hydrogen that exceeds by a few per cent the proportion required by the chemical formula for water. The potassium hydroxid is used for the purpose of absorbing any carbon dioxid that may be present, or be formed by the hot copper wire oxidizing hydrocarbon gases.

After the purification of the emanation the mercury in the reservoir J is drawn into H, the air being removed from H by the water aspirator, and the emanation and helium pass into J. The gases are then pushed up by the mercury thru the stop-cock I, and into the desired capillary tube or container, which is sealed off. The volume of the helium being very small, for the vast majority of purposes it is unnecessary to remove it. The length of the tube connecting F with J is made great enough so that air may be admitted into J without forcing the mercury up into F.

The stop-cock I, has a mercury seal and contains no stop-cock grease. It will be noticed that the emanation passes thru no stop-cock except the one at I, and even this is unnecessary, and has been added for convenience of manipulation only. Stop-cock grease is not used because of the fact that like many organic substances, it is decomposed by the rays from the emanation and gives off gases.



Elaborate Glass Apparatus Used in Order to Fill the Small Capillary Treatment Tubes with the "Radium Emanation". The Bulb "A" Contains the Radium Salt Dissolved in Water, from Which the Gaseous Emanation Is Set Free.

The system of tubes and bulbs, K, L, M, is for the purpose of removing the air from the other tubes and reservoirs by means of a pump attached at M. This is done at the beginning, and after that no air enters the reservoirs except occasionally when it becomes necessary to renew the oxidized wire or the phosphor-pentoxid, etc.

In Fig. 1 may be seen the elaborate apparatus constructed after the plan explained above. The frame-work is of angle iron and the whole is set in a base of concrete so as to make it impervious to all shocks which might damage the delicate apparatus.

(*Continued on page* 200)

LET ELECTRICITY WIND YOUR PHONOGRAPH.

A new electric motor winder adopted for attachment to any style phonograph

Winds any Phonograph by Electricity. Attached in place of Winding Handle.

so as to still retain the spring motor drive, which has so far proven the most satisfactory, has been invented by Joseph W. Jones who originated the *Jones Speedomcter* of world fame, the disc record which is the foundation of talking machine success, the taximeter, etc., etc. The new motor winder uses no current, except when actually winding up the spring.

In case of failure of lighting current or that no current is available, the winder may be instantly detached and the old-style crank used.

In case the user moves to a district where current is not suitable to his motor winder, this may be exchanged by the dealer in that locality.

This useful device is said to operate one month for one cent's worth of electricity. It is easily and quickly attached in place of winding crank, being applied or detached with the use of only a screw-driver in less than a minute by anyone. The winder will automatically wind your talking machine and stop when it is sufficiently wound. By pressing down the push button on top of the motor it will wind at any time, and the makers recommend doing this before playing each record. The push button cannot be prest down until the motor has been attached to both the phonograph and electric current.

VISIBILITY OF RADIATION OF THE AVERAGE EYE.

It is important to know how the eye responds to lights of different colors but of the same energy value. Only during the past year the investigation of the relative sensibility of the average eye to light of different colors was completed. The visibility of radiation of 130 subjects was determined, and various applications were made of these data to problems in radiometry.

A solution of salts was prepared which has a transmission curve coinciding very closely with the visibility curve of the average eye. Using a cell containing this solution, interposed between a thermopile and a source of light, further tests were made of this combination as a physical photometer. Using these visibility data, computation shows that the eye is so sensitive that the minimum perceptible light is probably *less than one billionth erg.*

Popular Astronomy

DARK STARS

By ISABEL M. LEWIS
Of the U. S. Naval Observatory

WHAT a vacation is to our tired bodies, Stellar Space should be to our minds. In the entire realm of Science there is nothing more elevating, nothing more ennobling than the study of Astronomy. Infinite space holds forth so many wonders and enlarges our mental horizon so enormously that modern man or woman must consider his or her education incomplete without at least a rudimentary knowledge of the wondrous world spread out in space all around us.

Astronomy is considered by many a dry, uninteresting science, good only for "highbrows." The opposite is the case. It is neither dry nor difficult of understanding, and once the mind becomes interested in its study, an entirely new and beautiful world is opened to it.

There is nothing more refreshing, nothing more satisfying to our minds than cutting loose for a few hours from our humdrum existence and delving into the boundless ether, where time and space are one, where a million years leave hardly an impression, and where a billion miles are so microscopically small that they are entirely lost in the gulf of infinite space . . . .

The writer, an ardent student of astronomy, has always wished to present to our readers popular and non-technical articles on the wonders of the Universe. No connection, however, could be made with competent writers who could present the difficult subject in a manner acceptable to EXPERIMENTER readers.

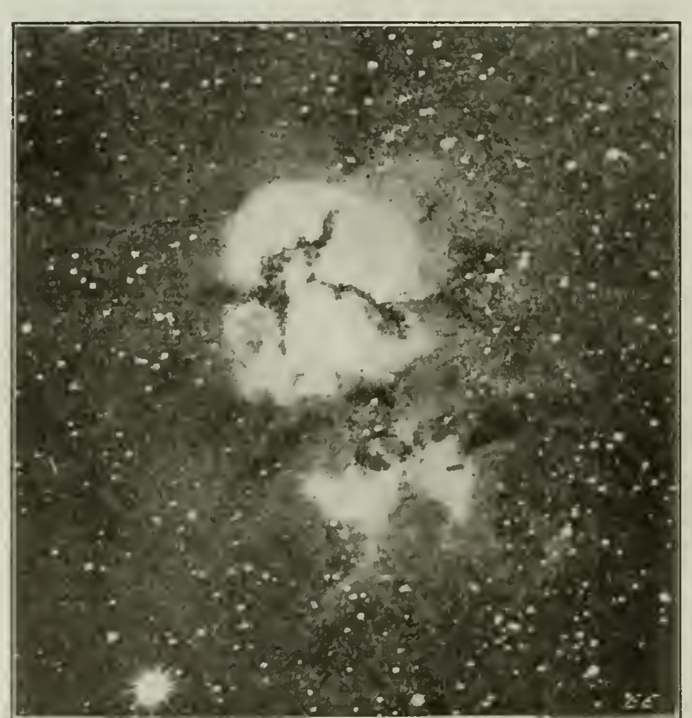
It affords us considerable satisfaction, therefore, that we are able to present herewith the first of a series of astronomical articles from the pen of Mrs. Isabel M. Lewis. Mrs. Lewis, who is connected with the U. S. Naval Observatory, has written a great many excellent astronomical articles for the New York "Sun," and other newspapers, which have created widespread attention and very favorable comment. Mrs. Lewis, who is a very exact as well as a highly learned writer, has the rare faculty of interpreting difficult and dry subjects in a popular manner, which makes us feel certain that our many readers will welcome her articles enthusiastically.

The ELECTRICAL EXPERIMENTER has furthermore secured exclusive magazine rights for all of Mrs. Lewis' articles for the term of one year. Her articles will not appear in any other scientific magazine. The article in the August issue,—an intensely interesting subject—will treat on "Gaseous Nebulae."

H. GERNSBACK.

THE existence of dark stars and dark nebulous tracts of matter in the heavens is now considered to be an established fact. The range of the actual as well as the apparent brightness of the stars has been found to be tremendous. The brilliant *Canopus* at an immeasurable distance from the earth is conservatively estimated to have fully *ten thousand times* the light-giving power of the sun, while an excessively faint star of a deep red tinge comparatively close to the solar system possesses but a *five-ten thousandth* part of the light of our luminary. The giant star Canopus has at least twenty million times the brightness of the little red dwarf star. There is no reason to believe, moreover, that this extremely faint star marks the lower limit of stellar brightness. A gradual decrease in the light-giving power of this star would place it before many ages in the ranks of extinct suns, cold, dark bodies pursuing their unseen way thru the universe in numbers that we have at present no means of estimating. The evolution of the stars has been traced thru all stages from nebulae to near-extinction and it is logical to assume that the process of evolution is not completed until the star has ceased to shine. Since the energy of a star is finite, it is assumed that the star will exist for a finite interval of time, however great this interval may appear as measured by the standards of man.

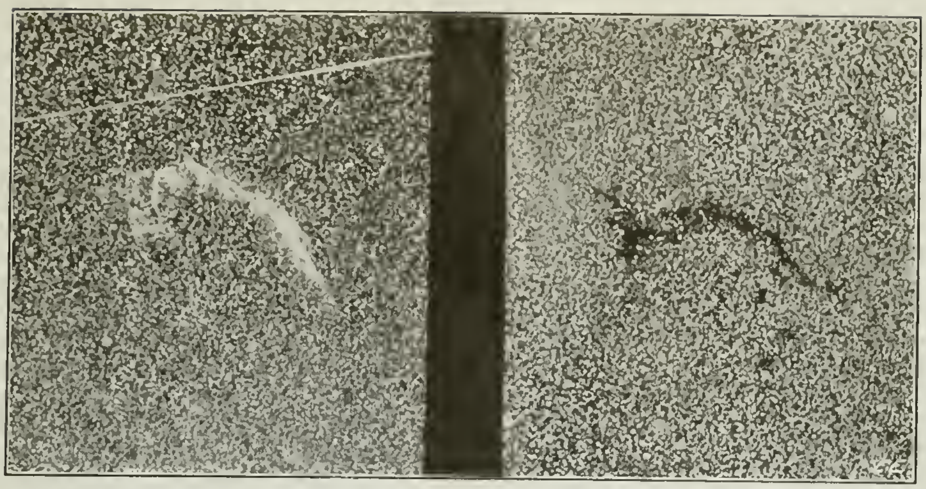
Whether or not actual collisions and close approaches of suns may start the evolutionary process anew is at present a matter of conjecture. The sudden flaring-up of temporary stars or *Novae*, as they are called, is believed by some to be a visible sign of the rebirth of stars thru collisions or encounters of dark bodies or their passage thru wisps of dark nebulous tracts of matter such as are known to exist in our stellar universe. The true nature of the Novae has not yet been definitely determined, however. So far there are difficulties in the way of all theories advanced to explain these rare phenomena of the heavens, tho their connection in some way with matter previously emitting no light seems a certainty, especially since they occur without exception in the Milky Way, a portion of the heavens where dark absorbing matter of a nebulous nature is intermingled with dense star clouds. The extent of these dark nebulous tracts must be enormous since it is known that their distance is very great and they spread over a space in the heavens that would normally be occupied by many stars. Light, traveling at the rate of 186,000 miles a second, would take many years to traverse from one end to the other of these dark nebulae that emit no light appreciable to the eye. In some instances dark regions merge into luminous wisps in which one or more stars are frequently enwrapt. The density of these dark nebulae is extremely low and their total mass very small in comparison to the great volume of space that they fill.



The Trifid Nebula in Sagittarius Photographed With the Crossley Reflector of the Lick Observatory, Showing How Dark Gaseous Material Is Frequently Found in Connection with Bright Nebulae.

Dark nebulae are presumably nebulae that for some reason never condensed into stellar form, but lost their light and heat while still in nebular condition. In many instances they may be the remains of the material swept up by the stars. The forms of some dark nebulae strikingly resemble those of a number of nebulae shining by their own light. These nebulae doubtless never possest the conditions essential to a successful entry upon the process of stellar development and drifted on to extinction in their original form.

There are also indications that many stars do not run the full course of evolution from youth to ripe old age, but become devoid of light and heat giving power even before the middle-aged period of star life is attained. Such stars are evidently lacking in characteristics essential to the successful development and prolonged maintenance of a *photosphere*, as the outer illuminating surface of the star is called. A study of



Photographed at the Yerkes Observatory by Prof. E. E. Barnard, Who Pointed Out the Striking Resemblance Between the Dark Region in Cepheus (on the Right) and the Bright Gaseous Nebula in Cygnus (on the Left). The Dark Object Is Doubtless an Extinct Nebula.

double and multiple star systems reveals these facts. It has been found that on the average *one star in every three* belongs to a star system of two or more stars revolving around a common center of gravity. Now evidently all stars belonging to the same system and physically connected came into being at the same time and should be approximately equal in light-giving power provided they do not differ greatly in mass. As a matter of fact, while one member of a double star system is at the height of its development and shines with intense brilliancy, the other is as often as not practically devoid of light, tho in volume, and occasionally in mass, it may surpass its brilliant companion. So feebly luminous are the fainter members of some of these systems that their light is not appreciable to us at all and we only know of their presence by the disturbance they produce in the motion of the brighter companion. Tho some of these stars shine feebly, others appear to be dark in the strictest sense. For some reason they proved to be imperfect radiators and become spent before their time. On the other hand, there are some physically connected systems of stars of which all the members are far advanced in evolution. They appear to have nearly run their allotted course and are nearing extinction. Many such connected systems of stars may be traveling thru the heavens, totally devoid of light, for all we know to the contrary.

There is great diversity in double and multiple star systems and their study forms a most fascinating branch of astronomy and one most fruitful of results. The orbits of the physically connected stars may be inclined at various angles with each other and with the earth and may vary in shape from almost perfect circles to highly eccentric ellipses. The stars themselves are sometimes spherical and sometimes greatly elongated or egg-shaped under the influence of tidal forces acting between the two bodies. They may revolve almost in contact, appearing as one star telescopically, or they may be so widely separated that they appear as beautiful little double stars, often of contrasting colors such as red and green or blue and yellow. In some instances a closely revolving pair performing a revolution in a few days around their center of gravity is encircled by a distant companion revolving around the close pair in a period of several hundred years.

A most powerful instrument of research in the study of double stars is the *spectroscope* and stars too close to be detected by other means are referred to as *spectroscopic binaries.* The great majority of double stars belong to this class.

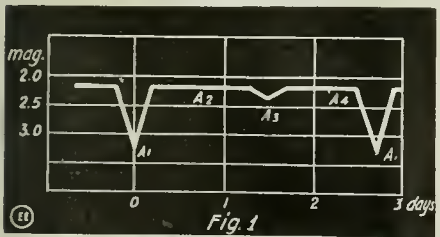


Fig. 1. Light Curve of the Double Star System—Algol. The Cycle of Light Variation Is Completed In 2.87 days. The Brightness of the System Is Constant for Most of the time at 2.1 Magnitude, but Suddenly Drops In 4.5 Hours to 3.2 Magnitude, Which Represents a Loss of 64 Per Cent of the Total Light of the System. It remains at Minimum Brightness Less than .5 Hour and Quickly Regains Maximum Brightness In a Period of 3.5 Hours. The Secondary Minimum at A_3 Occurs When the Bright Star Eclipses the Faint Star.

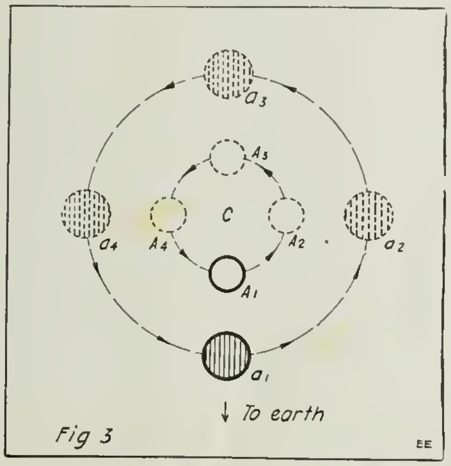


Fig. 3. Diagrams Showing Relative Positions of the Two Stars of the Algol System In Their Orbits. C Is the Center of Gravity of the System. The Inner Circle Is the Orbit of the Bright Star, A, and the Outer Circle the Orbit of the Dark Star "a." Orbital Motions Are Counter-Clockwise In the Direction of the Arrows. The Two Stars Always Move So as to Keep In a Straight Line With C.

The spectroscope consists essentially of a glass prism for separating white light into a band of color of rainbow hue known as the spectrum. Best results are obtained when the light from the star is let in thru a slit placed usually in the focus of the telescope. The ray of composite light coming from the star after passing thru the prism is broken up into rays of various wave lengths, arranged along the visible spectrum from the red thru the yellow, green, blue and indigo in order to the violet, the longest wave lengths being in the red and the shortest in the violet end of the spectrum. Below the red come the infra-red rays and beyond the violet the ultra-violet rays, both invisible to the eye. The spectrum is viewed by the observer at the eye-end of the telescope or is photographed by placing a photographic plate in the same position. The photographed spectra of the stars are spoken of as *spectrograms.* The application of spectroscopy to the study of binary systems rests upon the simple principle that motion of the source of light, or star, in the line of sight, towards or away from the observer, causes a displacement of all the lines of the spectrum and the amount of the displacement is a measure of the velocity of the motion. If the star is moving toward the observer the lines are displayed toward the violet end of the spectrum because the frequency of the wave vibrations is increased, the waves shortened in length, and therefore the lines all shifted in the direction of the shortest wave lengths. On the other hand, if the star is moving away from the observer the frequency of the vibrations is lessened and the lines are shifted toward the direction of greater wave length, the red end of the spectrum.

If a double star consists of two bright components there will be two spectra visible and two sets of lines, the spectra of the two stars over-lapping and of course the brighter spectrum belonging to the brighter star. The more massive star will describe the smaller orbit and its lines will show the smaller displacement. Usually the spectrum of the faint companion is too dim to be seen, but the periodic swaying of the lines of the bright star show that it is describing an orbit under the influence of an unseen companion. It has been found that in some instances the dark companion has *ten times the volume* of the bright star but only *one-tenth the total light.* In other systems the stars are of equal size but unequal brightness. In the majority of instances the dark companions are more bulky but possess less density than the bright stars. If they are smaller than the brighter primaries the difference is always slight. The distance between the stars is, as a rule, not great, usually a few million miles, or several times the radius of one of the stars. As a result these spectroscopic binaries are usually eclipsing binaries as well. That is, as seen from the earth one star periodically passes before

(*Continued on page* 198)

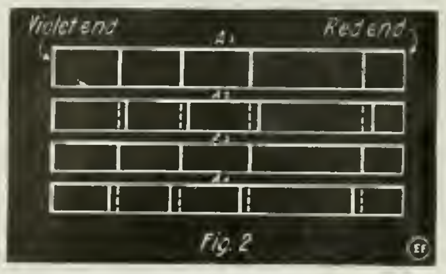


Fig. 2. Diagram Showing Displacement of Lines In the Spectra of Algol, Corresponding to the Positions A_1, A_2, A_3 and A_4 In Fig. 3. In Positions A_1 and A_3 There Are No Displacements of the Lines Since the Star Is Moving Across the Line of Sight. In A_2 the Star Is Receding From the Earth In the Line of Sight and Displacement Is Toward the Red End of the Spectrum. In A_4 the Star Is Approaching the Earth In the Line of Sight and Displacement Is Toward the Violet End of the Spectrum.

NEW ELECTRIC HOME MOTOR FOR WOMEN.

People everywhere are rapidly awakening to the fact that electrical labor-saving

With this New Electric Motor for the Kitchen Much Time and Labor Can Be Saved. It Even Makes Butter.

devices for the home are fast becoming a necessity. This year when labor of all kinds is at a premium, and the general wave of "efficiency" is sweeping the country, the demand for electrical home devices is going to be greater than ever.

The electric motor here illustrated is easily convertible and with different attachments can be made to churn butter, whip cream, eggs, etc., polish silver, and sharpen knives. It also has a vibrator attachment for massage, with a variety of applicators. It can be made into an electric fan by attaching guard, blades, etc.

The outfit here shown is a churn and mixer motor. This outfit includes the motor with handle, cords, plug, and rheostat, supports for jar with nickel-plated top, which will fit any Mason screw-top jar; also butter churn and cream whipper. With this outfit comes complete instructions for making butter. Its cost is extremely low.

HATCHING "CHICKS" BY ELECTRICITY.

The day of the old, smelly oil-heated chick incubator is rapidly disappearing. Enter the modern electrically heated and controlled incubator of the type here illustrated. And not only do these electric incubators serve the wants of the farmer and chicken fancier, but the army department finds many diversified uses for them. Among other applications, the army medical corps is employing them for developing cultures; the army camps are using them for hatching chicks; and they have hatched almost every kind of egg, from that of the silk worm, the smallest, down to the large ostrich egg, besides those of the pigeon, alligator, turkey, duck, swan, emu and the Queen bee.

New Electric Incubator With a Capacity of 126 Eggs. It Requires 21 Kilowatt-Hours Per Hatch.

The egg chambers are made of California redwood thruout. Double walled, lined with deadening felt and jute board. They are packed with animal wool, the very best insulating material, and the doors are fitted with double glass with dead air space.

The electric heaters consist of coils of special alloy resistance wire, wound on insulating cores and supported strongly above the eggs in egg chamber. The wire is distributed on the cores properly to give even distribution of heat in the egg chamber.

Regulation is effected by a special regulator operating a simple make and break switch equipt with non-fusible points which is adjusted by a single screw for higher or lower temperatures. No extra magnets, or relays are needed to break the small amount of current used in these electric incubators.

Tested thermometers are furnished and an adjustable holder is supplied which holds the thermometer in proper position to be read without opening the door of machine. Thermometer can be raised to remove egg tray for turning.

The egg trays are of galvanized steel with reinforced frame and galvanized steel cloth corrugated bottoms. Corrugation hold eggs in convenient position for turning. Can be scalded after hatch is finished. The nursery drawers are removable without opening doors of machine. The hatched chicks can be removed without disturbing eggs on trays.

A small 2 candle-power lamp is installed in the egg chamber which lights up when the regulator turns the heat into the heating coils, and goes out when the heat is turned off. A very convenient means of telling how the machine is operating. This lamp also enables the operator to read the thermometer no matter how dark the room may be.

These electric incubators are very accurate in their temperature regulation and the average current consumption is very low, considering the superior results obtained, as the following figures show:

Capacity	Energy Consumed
504 eggs	52 Kilowatt Hours per Hatch.
252 eggs	26 Kilowatt Hours per Hatch.
126 eggs	21 Kilowatt Hours per Hatch.
63 eggs	13 Kilowatt Hours per Hatch.

In extra well built incubator houses these figures will be somewhat lower.

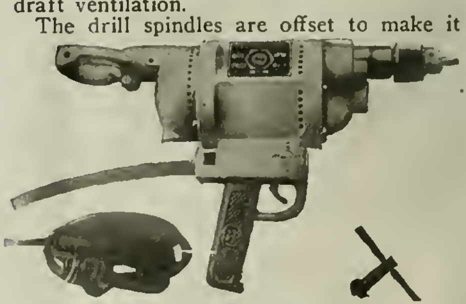
ELECTRIC DRILL HAS PISTOL GRIP AND SWITCH.

The new portable electric drill here illustrated has a pistol grip and trigger switch, and has been designed with special attention to the prevention of breakage of drills when operating the switch.

The control is that of the automatic pistol, one finger operating the trigger switch without the slightest effect on the steadiness of the aim or the support of the tool. There is no releasing of the grip to turn a switch, press a button, push or pull a handle, at the moment the drill breaks thru, allowing the weight to sag on the drill bit. When the drill goes thru the work, you instinctively tighten your grip, retaining control and stopping the drill without breaking the bit.

The casing of the drill is made of aluminum, to reduce the weight. It has a specially designed series, compensated interpoled type motor, which will operate on either alternating or direct current. The motor is kept cool by automatic forced draft ventilation.

The drill spindles are offset to make it



This Electric Drill Has Pistol Grip and Trigger Switch.

easier to drill in close corners. These new drills are available in five sizes; the smallest size weighing but 6⅜ pounds, and capable of drilling holes up to 3-16" in diameter. There is also a ⅜", ½", ⅝" and ⅞" size, the latter weighing only 24 pounds.

TEACHING "HER" ELECTRICITY.

By F. C. Davis

"Jack," said his best girl, one night when they were alone in the parlor, "you are *so* wonderful and you know *so* much about electricity. Won't you tell me all about it?"

"Sure thing. What do you want to know?"

"Well, what is insulation?"

"Insulation? Now let me see; how will I illustrate? Oh, yes. Please put on a glove, . . . so. I take your hand in mine, . . . so, *it is now insulated.*"

"I see. And what is a connector?"

"A connector? Take off your glove, . . . our hands touch; *they connect.* See?"

"Why, it's ridiculously simple! What is an ampere?"

"That's a little harder to illustrate. It is the power of the electricity. The power —I take your hand— it is the power that makes me do it. You see?"

"Perfectly. But what is a volt?"

"A volt? It is the pressure of the electricity?"

He squeezed her hand tighter.

"That's voltage, electrically speaking."

"Why, everything is so easy—and nice. But what is induction?"

"Hum! That's a poser. Well, I take your hand. The power and the pressure make my heart beat faster; *it induces* it to speed up."

"How remarkably simple."

"Anything else?"

"Yes. What is resistance?"

"Well—well. If I were a—a—er—to attempt to—er kiss you, now, I would meet with resistance, wouldn't I?"

"Well, er—er—er—I don't believe I quite understand. Can't you illustrate that?"

So he illustrated it; but there was *no resistance.*

"How wonderful," she fluted between sighs. "Now Jack, *dear,* what is a short-circuit?"

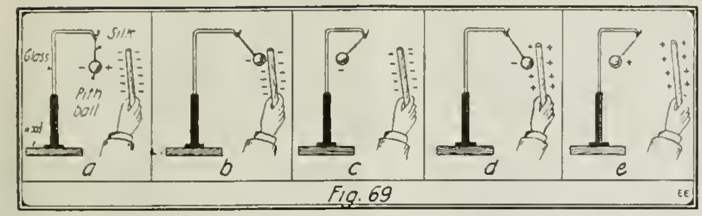
There was a loud step, and the door burst open and in rushed her father!

"I'll show you what a short-circuit is," he roared as he made for the sofa on which Jack had sat, but luckily sat no more, he having dived thru the window pane with a bang and a rush.

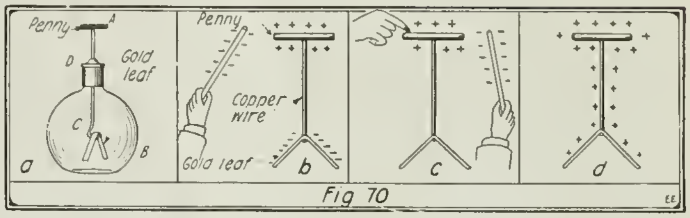
"Some *short-circuit,*" mused Pa, looking over the damage.

Experimental Physics

By JOHN J. FURIA, A. B., M. A., (Columbia University)



Interesting Experiments With Electrified Pith Ball.



The Electroscope and Distribution of Charges.

Lesson 13—Static Electricity
Experiment 74.

IF a fountain pen is rubbed on the sleeve of the coat and then brought near some bits of paper (or, better, pith balls), these objects will be found to jump towards the pen. The same effect can also be produced by rubbing a variety of other substances, such as glass and silk; sealing wax and flannel; hard rubber (ebonite) and cat's fur; etc. (This experimer was first tried in 600 B. C. by Thales of reece, who used amber and silk and the process is called *clectrification* after the Greek word *electron,* meaning amber). Altho so long a time has elapsed since electrification was discovered, even at this late date we do not know much about the nature of electricity, but we do know very well the laws governing its action.

Experiment 75—Suspend a pith ball by a silk thread as in Fig. 69-a. (The stand can be easily made by bending a piece of glass tubing after heating it in a Bunsen flame and attaching it to a wood base by sealing wax). Bring the fountain pen (which has been rubbed on the sleeve) near the pith ball. The pith ball will first be *attracted* by the pen and then immediately on touching will be *repelled.* Evidently the state of the pith ball is changed upon coming in contact with the electrified fountain pen. Rub a glass rod with silk and bring the rod near the pith ball. If we assume the same laws of force as we did in the case of magnetism we find that the behavior of the pith ball is easily accounted for. Referring to Fig. 69, the pith ball in (a) is neutral, i.e., it contains equal amounts of positive and negative charges. As the electrified pen is brought near (let us call its charge negative) by induction the part near the pen become positive and since *unlike charges attract,* the pith ball is attracted. On coming in contact, however, the strong negative charge on the pen causes the pith ball to become negatively charged (Fig. 69-b.) Then since *like charges repel,* the pith ball is repelled (Fig. 69-c.) Now on bringing the glass rod near, we find that the pith ball is attracted. Therefore since there is attraction and the pith ball is negative the glass rod must be charged positive, i.e., glass when charged has the opposite charge to the fountain pen when charged. Immediately on contact (Fig. 69-d) the strong positive charge of the glass rod causes the pith ball to be positively charged and repulsion takes place, (Fig. 69-e). It is obvious that just as in the case of magnetism, repulsion is a better test for electrification than *attraction,* since *even a neutral object will be attracted by induction, but only a charged object can be repelled.*

Experiment 76—The *electroscope* (an instrument for measuring forces of electrification) is very simple and depends for its operation on the principle of repulsion between like electrical charges. Thru a rubber stopper (D) insert a piece of heavy copper wire (C) bent in shape of Fig. 70. Solder a penny (A) to this wire. Cut a small strip of gold lead (such as is used by sign painters) about ¼" x 2½" and place it over the hook of (C). Insert all this in a flask or bottle. This is now a good electroscope and in diagrams is represented as in (Fig. 70-b). If now a *negatively charged* rod (fountain pen) is brought up to the electroscope (Fig. 70-b) the positive of the neutral electroscope is attracted to the penny, leaving an equal amount of negative charge at the gold leaf. Since both sections of the gold leaf have the same charge they will repel each other and move apart; the greater the charge, the greater the force, and hence the further apart they will be forced. However, as soon as the rod is taken away, the positive from the penny will mix with the negative of the gold and the electroscope will become neutral or discharged.

Experiment 77—We have two methods of charging the electroscope permanently; by *contact* and by *induction.* If we bring a charged rod up to the electroscope and touch the penny with the rod, the gold leaves stay apart permanently and the electroscope is charged. As the negative rod approaches, the positive charge of the electroscope goes to the penny and the negative charge is left at the gold leaves. On contact the positive of the penny goes to the rod and tends to neutralize it, so that on removing the rod only negative electricity is left in the electroscope, *i.e.,* by contact the electroscope is charged with the same charge as the rod used. Charging by induction is a more complicated process, but is important in that the charging rod does not neutralize, *i.e.,* does not lose its charge. Bring rod up to electroscope as in Fig. 70-b, then *without touching* the rod to the penny, place the finger on penny (Fig. 70-c). The leaves will be found to collapse, the reason being that the negative of the gold leaves has past thru your body by way of the fingers; the positive staying at the penny because it is held by the negative of the charging rod. Being careful to still hold the rod near the penny take away your finger. Next remove the rod and the electroscope will be charged by induction, since the positive will distribute itself over the instrument as in Fig. 70-d. Note that no charge has been lost by the charging rod. If one is not careful to remove the finger before the rod is removed, the charge left in the electroscope now not being held by the rod also passes thru your body and the electroscope is not charged. By induction it should be noticed that on the electroscope we get a charge opposite to the rod. (If in the above experiments a glass rod is used, a similar but not as marked an effect will result, except that all signs will be reversed, *i.e.,* for positive we will have negative and vice versa.) If we touch a piece of metal to the penny of the electroscope and then touch the metal with a charged rod, we find that the metal allows the charge to pass from the rod to the leaves and we call the metal a *conductor.* On repeating this experiment, substituting glass, wood, sealing wax or hard rubber for the metal, we find that these substances do not allow the charge to pass. These materials are called *insulators* or *non-conductors.* Bring the flannel (with which you have rubbed the sealing wax or fountain pen or else the silk with which you have rubbed the glass rod) up to the electroscope. Now test the charge for sign. It is found to have the sign opposite to that of the rod. Furthermore the amount of divergence of the gold leaves shows us that positive and negative electricities always appear simultaneously and in equal amounts, *i.e.,* if we rub glass with silk the glass is charged *positively* and the silk *negatively* to the same extent.

Experiment 78—Let an insulated metal plate be connected to the electroscope by a conductor Fig. 71-a. Let another similar insulated metal plate be connected to earth (grounded); charge plate A and note the deflection of the electroscope leaves. Push B toward A and observe that as it gets nearer and nearer the leaves fall gradually, so that we may now add more charge to A

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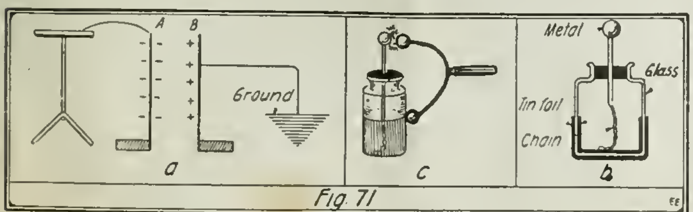
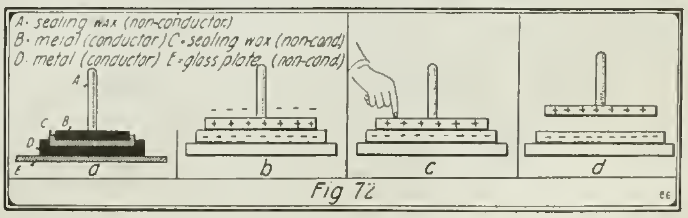
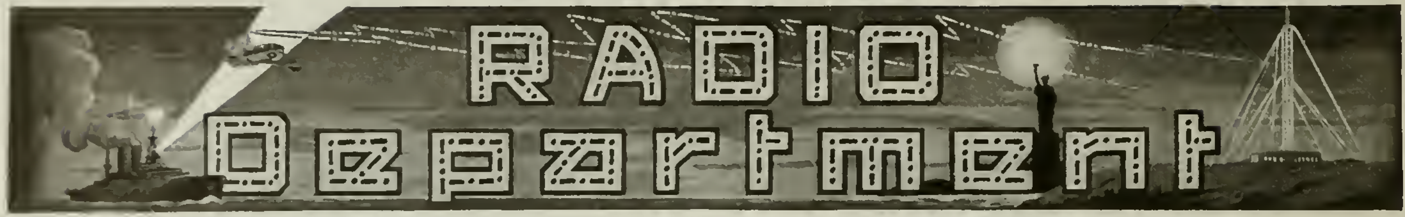


Experiments With the Leyden Jar.



Distribution of Charges On Electrophorus.



Colonel Carty Receives Edison Medal

DR. JOHN J. CARTY, Colonel in the United States Army Signal Corps and Chief Engineer of the American Telephone and Telegraph Company, has been awarded the *Edison Medal* in recognition of his services in developing the science and art of telephone engineering.

The medal was presented on Friday evening, May 17, at the annual meeting of the American Institute of Electrical Engineers in the Engineering Societies Building in West 39th Street, New York. Colonel Carty is the eighth American scientist to be honored in this way, the others being Elihu Thompson, Frank J. Sprague, George Westinghouse, William Stanley, Charles F. Brush, Alexander Graham Bell, and Nikola Tesla.

The Edison gold medal was founded in 1904 by the Edison Medal Association, an organization composed of old associates and friends of Thomas A. Edison. It is awarded annually by a committee of 24 members of the American Institute of Electrical Engineers, and was first awarded in 1909, the recipient being Elihu Thompson. It was designed by James Earle Frazer, and bears on its obverse a portrait of Thomas A. Edison, and on its reverse an allegorical conception of "The Genius of Electricity Crowned by Fame."

After Dr. E. W. Rice, Jr., President of the Institute, presented the medal, Colonel Carty in his speech of acceptance, gave credit for the American Telephone achievements to the engineers who have been associated with him in the Bell System and paid a tribute to Major General George O. Squier, Chief Signal Officer of the United States Army, for his work in planning before the United States entered the war, for the rapid mobilization of telephone wires and telephone men for Signal Corps work. Referring to the Bell System engineers, Colonel Carty said:

"We hear a great deal about the German scientist and the wonderful things he has done and has been planning. Many years ago, when German 'Kultur' was interpreted by many to mean German culture, it was suggested to me that we should send to Germany to get some of the Herr doctors to teach us the high science. I always opposed that, believing that the Yankee mind, the Yankee boy, when his attention was turned to scientific problems, would surely outdistance a German. I concluded that our work could be trusted to these young Yankee minds and that they should be trained in our work, and that thru them we would undertake to outdistance anything that has been done in Germany. That policy has worked out successfully. The young men who have collaborated with me all these years are graduates of over one hundred universities, all here in America. When at the opening of the war there was a searching of hearts and a census and a taking account of stock, to find out who was loyal and who was to be suspected, I know you will all be pleased to hear that among all of these scientists, and all of these engineers, all working in the Bell System, all over the United States, we were not able to find one single Hun. They were all true Americans to the core."

Colonel John J. Carty, U. S. Army Signal Corps, and Chief Engineer of the American Telephone and Telegraph Co., Who Was Recently Awarded the "Edison Medal."

More than any other man, Colonel Carty is responsible for the development of telephone engineering as it is known to-day, and it is peculiarly fitting that he should receive this new honor at a time when he is working day and night to promote the best military use of mediums of communication which have been developed largely thru his efforts in time of peace for the advancement of the nation's social, commercial, and industrial activities.

Colonel Carty is well known as the engineer of the great transcontinental telephone line, the longest in the world, and as the engineer who made possible wireless telephoning over distances up to 5,000 miles.

He entered the telephone business when it was in its infancy, and it would be difficult to find a phase of its development which does not bear some imprint of his genius. The technical achievements of Colonel Carty are so numerous as to prevent full recounting. He first pointed out the correct theory of induction between telephone circuits. That was in 1887. In 1888 he developed the bridging bell and pointed out the importance of the bridging principle of telephone construction in obtaining efficient operation of telephone systems and in constructing balanced metallic circuits. In 1889 he invented the principle of the best and most generally used common battery system, by which a number of telephone instruments may be simultaneously operated from a single central battery. During this period he also devised important improvements pertaining to switchboard circuits having to do with the "busy test" feature and the connecting in of operators' instruments.

In 1912 the telephone engineering force built up and directed by Colonel Carty had so far overcome the difficulties in the way of underground telephony as to make possible all-underground talking between New York and Washington, and by 1913 they had extended the range of underground telephony to connect Washington and Boston.

The year 1914 witnessed the fruition of the efforts of these engineers to bring transcontinental telephony into existence, and in 1915 Colonel Carty was able to present to the world important developments in wireless telephony, which made possible the hurling of words thru space across the American continent from Washington to Mare Island, California, from Washington to Hawaii, 4,900 miles distant, and from Washington to Paris, bringing Europe and America into speaking distance of each other for the first time.

Then came the threat of war with Germany, and in 1916 Colonel Carty co-operated with the Signal Corps of the Army and with the various departments of the Navy in making arrangements which would insure the readiness of the Bell Telephone System for military service in case this country did become involved in the great conflict. In 1917 these plans were put into active use with a marvelous degree of success.

Dr. Pupin said that—"Carty's life is filled with romance. He never went to college. At the age of 18, when other boys entered college, he entered the service of the American Bell Telephone Co. and at the age of 28 became Chief Engineer of the great New York Telephone Co. He started without getting honors, titles, and now he is a doctor I do not know how many times, and on the top of these titles, Colonel of

(*Continued on page* 196)

RADIO IN THE BULGARIAN ARMY.

The Bulgarian troops have equipt their signal corps divisions with the best radio apparatus available, as the accompanying photo shows. This particular radio outfit is a portable transmitting and receiving set, the various apparatus being divided up so as to pack in separate cabinets suitable for transport over mountainous or other rugged country when necessary.

The transmitter is operated on batteries, the operator in the center of the picture being shown in the act of manipulating the key. At the extreme right the receiving set may be seen, with the second operator wearing the head 'phones.

Photo © by International Film Service

Portable Radio Set Used by the Bulgarian Army. It Can Be Carried on Mules Over Mountain Passes.

The transmitter involves the use of an open-core transformer resembling a large spark coil, the interrupter being of special design. A quenched spark gap is used. The set is fitted with ammeter and voltmeter to indicate the primary current and voltage supplied the transmitter. A quickly collapsible antenna is carried with the outfit, which can be erected in a few minutes' time.

WOMAN RADIO EXPERT TEACHES DRAFT MEN.

One of the most useful war enterprises yet entered by women is that chosen by Miss Elise Owen, a New York girl, who, an expert radio operator herself, has, with the support of the Board of Education and the sanction of the Signal Corps, opened a class in radio operating for men in Class 1A of the draft. The class was started late in April and it already has an enrollment of 70 and plans are under way to increase its accommodations and activities. The accompanying photo shows Miss Owen and her Radio Class.

Photo © by Central News Photo Service

Miss Elise Owen, a New York Girl Who Is "Doing Her Bit" by Teaching Draft Men Wireless Telegraphy.

We have consistently advocated the teaching of radio as a patriotic as well as remunerative profession for women. The number of radio students is rapidly increasing at this time. Uncle Sam is sending out every week from 50 to 100 wireless operators from the big Harvard University school which was transferred to the government a year ago as a radio finishing school. It is the only institution of the kind in the country, and its classes have in the aggregate 5,000 ambitious youths.

This being a finishing school only those who are able to copy 10 words a minute in the continental code, which is much slower than the Morse, or regular telegraph code, are admitted for the 16 weeks course. To be sent out for service at sea they must be able to receive 22 words a minute, the minimum grading. There are many experts among the teaching force whose speed runs up to 32 words a minute, but beyond that a radio message would be hard to get. From three to six operators are assigned to each ship.

Small Portable Radio Set for Field Work

SINCE our entrance into the world conflict, American radio engineers have given considerable attention to the development and improvement of radio apparatus adaptable for various uses in the military service. The essential points to be considered in the making of such radio apparatus suitable for this kind of work are at once, simplicity, efficiency, and rugged construction.

Extremely Light Weight, Portable Wireless Transmitting Set, Intended for Military or Other Purposes. It Operates on Batteries and Utilizes a Special Spark Coil and Quenched Gap. A Hot Wire Radiation Meter Is Provided as well as Volt and Ammeter for the Primary Circuit.

All of the above necessary features have been incorporated in a new radio set designed by a New York radio engineer, Mr. A. B. Cole. The apparatus which he has evolved and which has proven very successful is operated from a battery and for this reason his transmitter is adaptable to various important military maneuvers where other, more cumbersome, apparatus would not adapt itself. The transmitter is shown at Fig. 1. The high tension e.m.f. used for charging the condenser is derived from a specially built spark coil which is enclosed in the case. A new design of independent vibrator is utilized for interrupting the storage battery current necessary to operate the coil. This interrupter is seen in the lower left hand of the panel. An ammeter and volt-meter are interposed in the primary of the induction coil and are used for the purpose of indicating the current and voltage input into the low tension primary circuit. These meters are stationed at the lower right end of the panel. A key is connected in the primary circuit and is also mounted on the panel.

The high tension and oscillatory circuit apparatus consists of a high tension condenser placed within the case; this condenser being charged by the secondary of the spark coil. The condenser is allowed to discharge thru a specially built quenched spark gap and thru the primary of a compactly built oscillation transformer. The gap is enclosed within the cabinet, and a large insulated knob is connected to the movable electrode, which is seen to the right of the independent vibrator. A very small adjustment is necessary to bring the gap to proper operation, as will be evident from the small swing of the pointer. The inductance of the primary oscillation transformer is variable, and it is controlled by a multiple point switch which is located at the upper left-hand corner of the panel, while the multiple point switch to the right of the primary switch is used to control the inductance of the oscillation transformer secondary. A thermo - couple high frequency ammeter is interposed in the ground lead of the open oscillatory circuit, and this meter is located in the upper right hand corner of the panel. The two binding posts placed in the center of the panel are used to connect the ground and antenna. The telephone switch in the foreground is used to connect or disconnect the transmitting circuit from the antenna, and is also used to connect or disconnect the receiving set, if such is to be used in connection with this transmitting outfit. A plug for connecting a receiving set, so that it may utilize the same transmitting antenna, is placed in front of the quenched gap control handle. The plug to the left of this receiving plug is used to connect the source of power necessary to operate the spark coil, which is generally a six-volt storage battery.

The complete transmitting panel is mounted in a well insulated and ruggedly constructed case and is supplied with a leather carrying belt, the complete equipment being extremely light in weight.

The receiving set accompanying the above transmitting outfit is shown opposite. Altho it is not essential to use this particular receiving set, it was found, however, that most favorable results were obtainable from this particular type of portable receiving apparatus. This set is of the tightly coupled, capacity control type. It comprises a fixt inductance wound on a special tube and mounted within the case. Two condensers of the variable, air dielectric type are used entirely for tuning purposes, and these are seen on the upper part of the panel. A crystal detector rectifies the incoming, radio frequency oscillations. This detector is in the lower right hand corner of the panel. A test buzzer is also a part of the equipment, this being used to adjust the detector crystal to maximum sensitivity. The buzzer push button is located in front of the crystal detector stand, while the buzzer is placed at the central left hand portion of the panel. The plug in front of the buzzer is used to connect the telephone receivers, while the plug at the upper center of the panel serves to connect the antenna and ground wires to the receiving set. A partition is provided at the right hand part of the case to accommodate the telephone receivers when the set is not in use. The case of this receiving set is substantially made so as to stand heavy wear and rough use.

TEST WIRELESS CONTROL.

Announcement that satisfactory tests have been made of a military airplane controlled wholly by wireless was made at San Diego, Calif., recently by Flight Instructor N. B. Robbins of the Rockwell field signal corps aviation school. The tests, he said, were made a short time ago, the controls being 12 miles apart.

The new machine, it is announced, carries neither pilot nor observer. It is equipt at present to carry only heavy freight or explosive bombs. The pilot guiding the machine may be in another airplane, in a dirigible or anywhere on the ground. Robbins says that an aviator driving the control in the machine ahead of him may remain fully 15 miles behind. He also says that the machine may be built for one-fourth the cost of a standard military machine. An electrical device for releasing a cargo of bombs is attached to the airplane.

Flight Instructor Robbins is the designer of one of the fastest airplanes ever built in this country, of a very fast motor and of a stabilizer used by the Royal British Flying Corps.

New Light Weight Radio Receiving Set, Well Adapted to All Military Requirements.

A HOLDER FOR A TUBULAR AUDION.

Those who have tubular Audions know what it is to have to connect the four wires up and then take them loose again after the receiving is over to put the bulb away in a safe place, so that it will not get broken or tampered with.

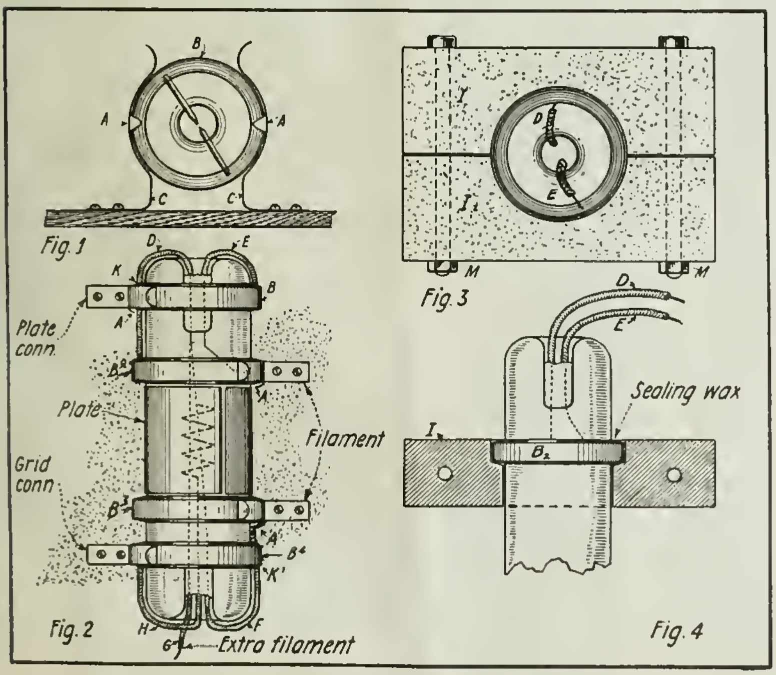
With this in mind I constructed a holder which has no wires to connect and at the same time makes good connections, and is not apt to fall out of place and break.

The construction of the holder can be seen from the drawings. The rings, B1, B2, B3 and B4 are made of nickel plated brass pipe which can be obtained from any plumber or hardware store. The rings are made about 3/16 or ¼ inch wide, and 1¼ inch in diameter. As can be seen the rings are held on the tube by sealing wax.

The best way to do this is to make a wooden mold as shown in figures 3 and 4. It will be necessary to get the wax good and hot in order to make it run in the mold. A hot knife blade will help a great deal in pressing the wax into place and smoothing it up afterward.

It is important to put the rings B2 and B3 on first, but connect the filament wires D and F before this. Then the other two rings may be put in place. A short piece of rubber tubing should be put over the wire at K and K1, where the filament wires go under the outside rings.

It will be seen from the drawing that the rings B and B2 are farther apart than B3 and B4. This arrangement makes it impossible to get the bulb connected up backwards as it will only fit one way. The clips are made as shown in figures 1 and 2. No dimensions are given as the builder will make them to suit himself anyway. In cutting out the strips for the clips, which are made of spring brass, do not forget the lugs A, figures 1 and 2. The purpose of these is to hold the bulb from falling or sliding downward. The wires should be soldered to the rings before the wax is put in as soldering would melt the wax. The extra filament wire G, can be left short and can be soldered on to lead F, when necessary. It can be seen that this method has many advantages over the regular way, as it is a very good idea to remove the bulb and lock it up when leaving the station, so that it can not be tampered with or broken.



The Audion Detector, Especially of the Tubular Form, Is Always a Difficult Instrument to Mount and Connect. The Present Design of Holder Solves the Problem Satisfactorily.

FRENCH BUILD RADIO TO AID AMERICA.

The French navy has just entered the international contest for the honor of building and possessing the most powerful wireless station in the world.

In support of its claims that its newly constructed station exceeds all others now in operation, the French navy has just demonstrated its ability to send messages as far as Australia. The stations there, which registered the messages from the new French naval station, were not powerful enough to acknowledge by wireless their receipt, but had the courtesy to reply by ordinary cable that the French wireless communications had been received.

The new French naval wireless station is in reality an acknowledgment of gratitude of the French navy to the United States for its entrance into the war.

The moment America made its formal declaration of war against the enemies of France, the French navy decided to erect immediately a powerful wireless station that would put France into constant and sure touch with America. It was planned also as a very effective safeguard against the submarines for the stream of troop ships and munition convoys which it was realized would soon be headed for France.

A site was accordingly chosen on the French coast, where it was most likely that one of the American naval bases would be establisht, and from where it would be able to pick up with the greatest degree of certainty distress messages from any American boat that might encounter a submarine.

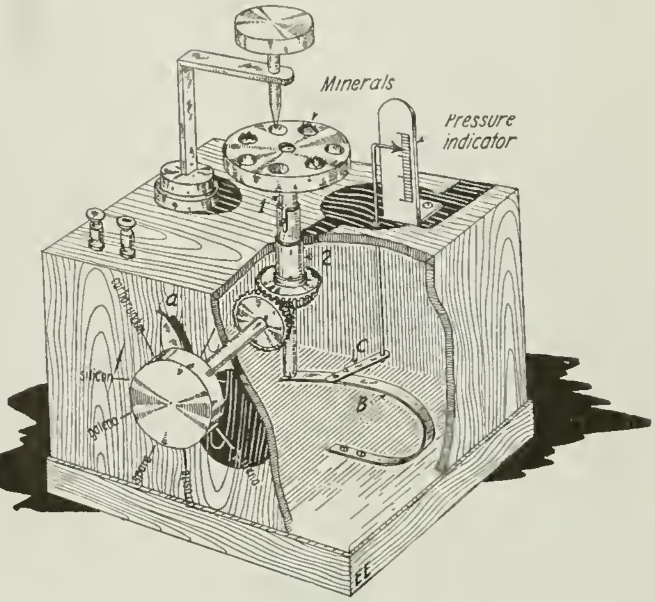
The metallic pylons of the French station are over 600 feet high. Perfected electrical equipment makes it possible to send out waves that will be received at any distance at which they can be picked up in the form of musical sounds instead of the ordinary crack-crack of the wireless. As a result of these musical intonations the receiver is always able to pick out the waves of the French wireless plant from all the other storm or wireless waves with which the air may be filled.

Waves can be sent out with a length of from 3,000 to 13,000 yards (approximately 2,700 to 11,890 meters) and which, as has already been demonstrated, carry as far as Australia.

The electrical apparatus furnishing the current for these waves is capable of producing 600 horsepower.

A RESEARCH TYPE OF DETECTOR.

Herewith I present drawings and specifications of a detector comprising two distinct merits. First—that it can be determined what pressure each mineral requires, pressure being recorded on the upright scale. Second—That the detector cup is made movable by means of gear-wheel attachments, and a graduated scale on the front of cabinet shows which mineral is under point of detector; other minerals may be brought under the point by turning the handle which revolves cup. It will be an easy matter to compile a set of *pressure* readings for each mineral contained in the cup, and from this a fair idea as to just what pressure each mineral requires, will be had.



This Form of "Research" Radio Detector Will Prove Extremely Valuable in Conducting Qualitative Tests on Various Crystals, as the Relative Pressure Applied on Each Crystal Is Indicated on the Scale.

As will be noted, no measurements are given; first, because the detector parts may be of different construction and material; secondly, because different size cogs may be used, as a whole any material on hand may be used if the original idea is carried out.

Contributed by E. T. J.

DR. FERDINAND BRAUN DIES.

Dr Ferdinand Braun, who shared the Nobel Peace Prize with Marconi in 1909, died April 20th in Kings County Hospital, in Brooklyn, in the sixty-eighth year of his age. He had been living with his son, Conrad, having come to the United States in 1915 as a witness in the litigation between the Marconi Company and the German company which then operated the wireless plants at Sayville, L. I., and Tuckerton, N. J. He had made a study of wireless since 1898, and it was claimed by his adherents that his discoveries had made the Marconi system possible.

His system of wireless transmission was used in Germany. He was born in Fulda, Germany, June 6, 1850, and graduated from the University of Berlin in 1872, with a work on the vibration of chords. He was for some years a professor of physics in Strassburg and Karlsruhe, and for ten years in the Tübingen University.

The How and Why of Radio Apparatus

By H. WINFIELD SECOR, Assoc. I. R. E.

NO. 9—TELEPHONE RECEIVERS.

From time to time we will describe one particular instrument used in either the radio transmitting or receiving set, explaining just how it works, and why. We have received so many requests from new readers asking for such explanations that we have decided to publish this matter in serial form. In the course of several issues all of the principal transmitting and receiving apparatus will have been covered. The subject for the ninth paper is TELEPHONE RECEIVERS.

THE telephone receiver as applied to radio-telegraphy and telephony is one of the most sensitive electrical detecting instruments ever devised. However, this does not mean that the *radio receiver,* as it is usually termed in wireless parlance, is the most efficient detector of weak electric currents. Quite the contrary, for it has been ascertained that such a receiver has an over-all efficiency of only *five per cent!** It was found by H. Abraham that less than *one one-thousandth* of the energy in the received current is transformed and transmitted to the air in the form of sound waves. Siemens conducted investigations which proved that the force of the air vibrations operating on a transmitter or microphone is *ten thousand* times greater than that of the vibrations reproduced by the receiver. Thus we see that the radio and electrical investigators of to-day have an excellent opportunity to devise and perfect a translating device of this nature that will show a higher efficiency than five per cent. Doubtless this ratio between input and output will eventually be raised to 50 or 75 per cent by some new principle of engineering design.

With all the losses in the telephone or radio receiver, however, it is interesting to note the infinitesimally small amount of energy required to give good clear signals or sounds; in fact, its sensitivity is almost incredible. Preece's investigations indicated that sound could be heard from a receiver when actuated by a current as small as .000,000,000,000,6 ampere. Tests by Kennelly indicated a minimum current of .000,-000,044 ampere. For good radio communication the received current should be equal to 40 micro-amperes, thru 25 ohms total antenna circuit resistance; this is equivalent to 40 x 10^{-9} watt = 4/40 erg per second. For audible signals the received antenna current should be about 10 microamperes thru 25 ohms total aerial circuit resistance; this is equal to 2.5 x 10^{-9} watts or 1/40 erg per second.

Referring to Fig. 1, A-B, there is shown a sectional view of a typical watch-case radio receiver. In general this receiver follows the same design as that of the standard telephone receiver, with the difference that in this case the permanent steel magnets are concentrated in a small ring so as to occupy less space. Two or more hardened steel magnet rings are used in the watch-case 'phone to which there are mechanically secured two soft steel pole-pieces, on either of which a magnet coil is wound as indicated. The metal (or molded insulation) shell of the receiver carries a threaded cap with an opening at its center, thru which the sound waves produced by the vibrations of the soft iron diafram pass to the ear chamber.

Practically all radio receivers follow this design, altho there are several types that have been tried which deviate somewhat from the principle here involved.

The receiver here shown is similar to the standard watch-case telephone receiver, with the exception that the magnet coils are wound to have a total or joint resistance of but 75 ohms for ordinary telephone work, whereas for translating radio signals, and owing to the very minute current available to act on the receiver, the two coils are usually wound to have a joint resistance of from 1000 ohms to 3000 ohms or more. The standard receiver for radio work has 1000 ohms resistance, or two thousands ohms for a set of two receivers connected in series. The magnet coils should, of course, always be wound with a pure insulated copper wire, and the size of wire used depends upon the resistance desired, varying from No. 36 B. & S. gage for a 75 ohm 'phone to No. 42 or smaller for a 1000 ohm or higher resistance 'phone.

The permanent steel magnet in the receiver sets up or maintains a constant magnetic force acting on the iron diafram, this action being more apparent from Fig. 1-B; thus when the receiver cap is screwed down properly, the diafram will be held rigidly at a slight distance from the pole-pieces, and will be pulled slightly toward them under normal conditions. The flux from the permanent magnet passes up one pole-piece across the air gap to diafram, thru the diafram to the second air gap, thru the second pole-piece and thence completes the magnetic circuit. If the cap is not screwed down sufficiently tight, or if the magnets are not properly adjusted, the permanent magnet flux may be sufficient to pull down the diafram against the pole-pieces in which event the receiver has to be overhauled, or the trouble may be overcome by tightening up the cap, or also in some cases it becomes necessary to place one or more paper rings under the diafram where it rests on the shell.

The action of the telephone or radio receiver is the same in every case. The vibration of the diafram so as to set up acoustic waves in the air is caused by sending a current of constantly changing strength around the coils wound on the soft iron pole-pieces. These currents in the case of the telephone are controlled by a *microphone* in a well-known manner, and each current fluctuation along the circuit follows accurately the fluctuations of the voice. These current fluctuations, which often occur at a rate of several hundred cycles per second, pass thru the magnet coils in the receiver and cause constant changes in the magnetic flux acting on the diafram: the flux from the electro-magnet coils either strengthening or weakening the flux from the permanent magnet which acts normally on the diafram, keeping it under constant stress. Where great sensitivity is desired, it is claimed that a permanent magnet thus used to "stress" the diafram causes it to respond more quickly and easily to weak currents. It is becoming standard practise in the telephone field to make more and more use of plain *unpolarized* receivers, which have been found to reproduce speech in a perfectly satisfactory manner.

Probably the most important part of the receiver is the *diafram.* This is usually made of a high grade soft annealed iron which is then coated with Japan to prevent rusting, and in the best types of radio receiver the diafram is *Sherardized* to prevent rusting. Gold plated diaframs have also been used. The diafram of the receiver fulfills the all-important function of transforming the vibrations created in the magnetic field into corresponding vibrations of the air which constitute *sound.* The diafram operates first as a part of the magnetic system, incidently as part of the electric system, and finally as a mechanical vibrating system. In each of these relations, faithful reproduction of the original sound or signal requires that the motion of the diafram shall correspond in respect to direction and relative amount, with that of the electromotive-force applied to the terminals of the electric circuit, this in turn being assumed to correspond faithfully to the vibrations of the original sound.*

For radio receiver circuits where the current is usually of the order of a few millionths of an ampere, and the voltage but a few millionths of a volt, it has been found that several parts of the receiver need re-designing and will bear a number of changes in proportion that would not augur well for the same receiver if it were to be utilized on a standard telephone circuit, where plenty of current and voltage are available. Experience in radio receiver design has shown that the diafram should be slightly less than two inches in diameter and clamped firmly all around the edge, the diafram itself being between four and eight mils thick. The natural pitch or vibration period of the diafram will be higher as the diameter and the thickness decrease, and vice versa.† In most cases the pole-pieces should be so near to the diafram as almost to pull it against them, and for this reason the magnet pole-pieces should be adjustable, as it will be found in practise that temperature has considerable to do with the best operation of the receiver, the diafram expanding and contracting considerably under changes of temperature, which may easily range from several degrees below zero in northern climates up to one hundred and fifteen degrees Fahrenheit in the Tropics.

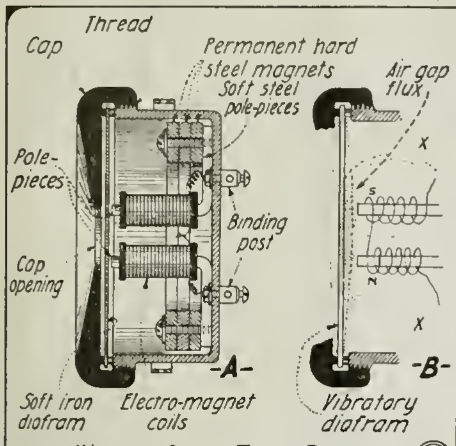
The technical consideration of the action taking place in a radio or telephone receiver is best understood perhaps by analyzing the changes occurring in the magnetic circuit, which is of course the all-important factor involved in the transformation of electric currents into sound waves. The pull on the diafram is approximately proportional to Φ^2, where Φ is the magnetic flux passing from pole to pole thru the metal of the diafram. A current in the windings makes the pull $(\Phi + d\,\Phi)^2$. The increased pull due to the current is proportional to $2\,\Phi\,d\,\Phi$, neglecting a relatively small quantity. Therefore, the greater the permanent flux, the greater the efficiency of a good instrument. The flux is increased by strengthening the magnets or by using thicker diaframs, also by reducing the air gaps between the diafram and pole-pieces, but magnetic saturation of the diafram sets the limit to useful increase of strength of magnet, as readily becomes evident. If, with a certain thickness of diafram we unnecessarily increase the strength of the magnet in the receiver, the superfluous magnetic flux which cannot be

(Continued on page 210)

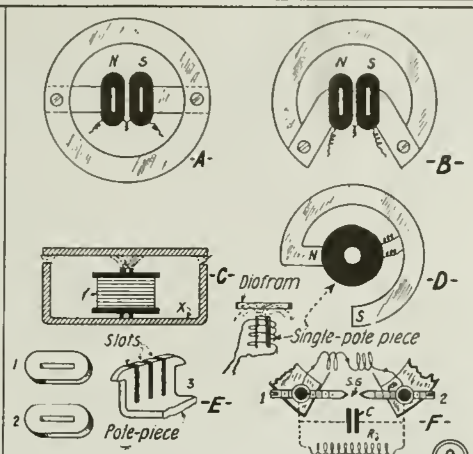
* G. W. Pickard, *Western Electrician*, 58: 899, May 6, 1911.

* Shepardson, "Telephone Apparatus," 1917.
† W. H. Eccles, "Wireless Telegraphy and Telephony," 1916.

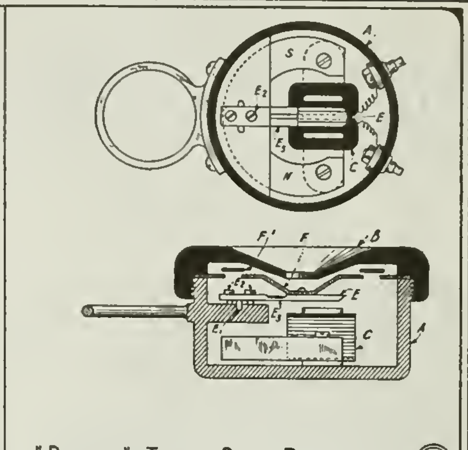
THE HOW AND WHY OF RADIO APPARATUS—RADIO RECEIVERS



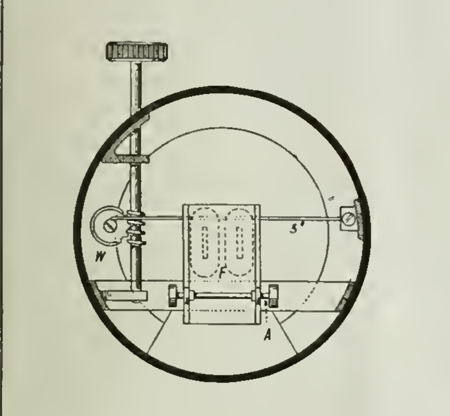
WATCH-CASE TYPE RECEIVER (1)



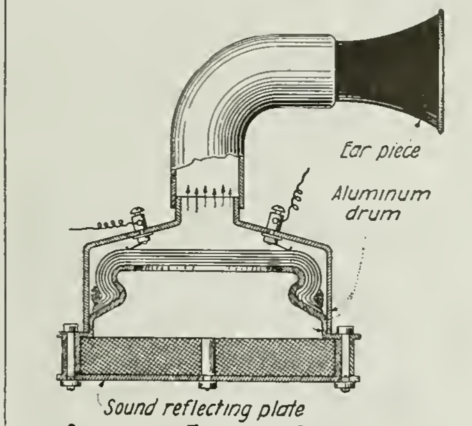
WATCH-CASE 'PHONE DETAILS (2)



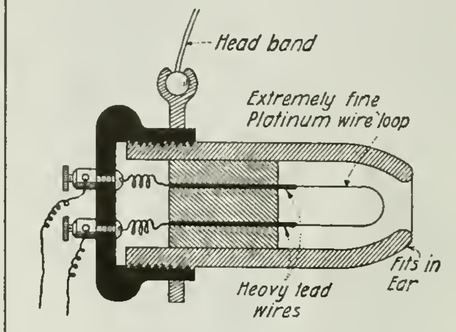
"BROWN" TUNED REED RECEIVER (3)



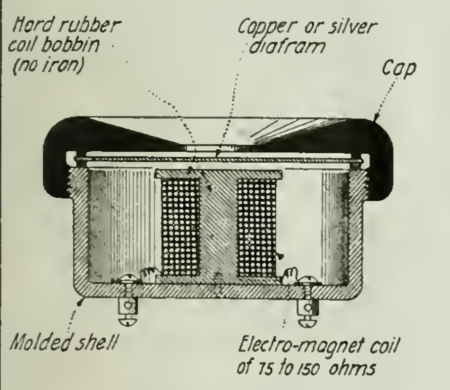
THE MONO-TELEPHONE (4)



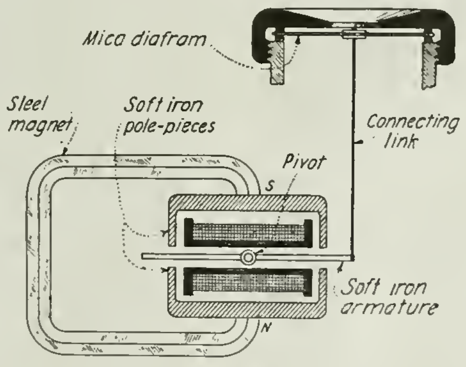
CONDENSER TELEPHONE RECEIVER (5)



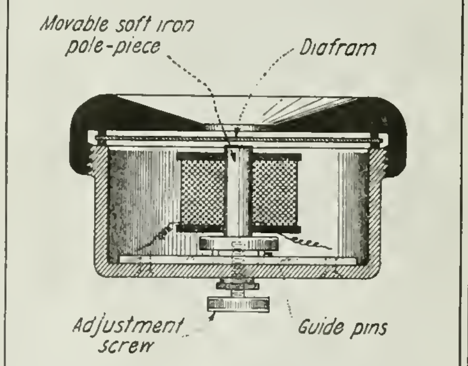
THERMAL TELEPHONE (6)



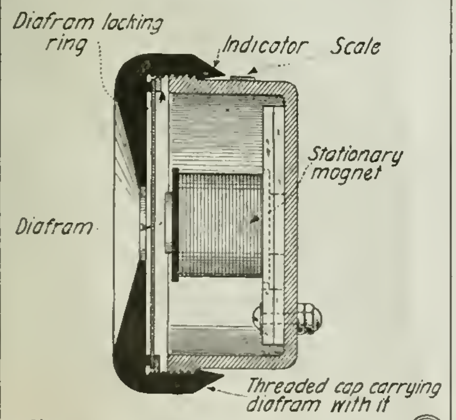
THE "PIERCE" DYNAMOMETER TELEPHONE (7)



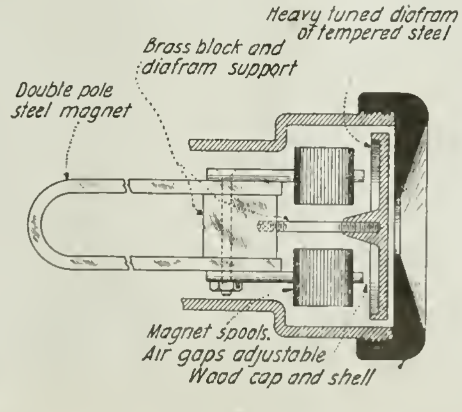
THE "BALDWIN" TELEPHONE (8)



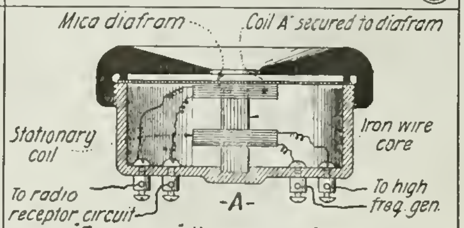
ADJUSTABLE POLE-PIECE 'PHONE (9)



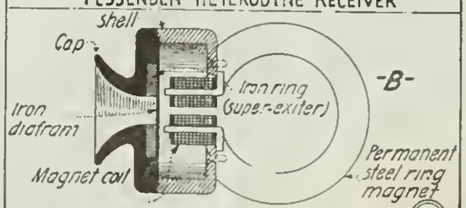
"LEACH" ADJ. DIAFRAM 'PHONE (10)



THE "BERGER" MONO-TONE RECEIVER (11)



"FESSENDEN" HETERODYNE RECEIVER



THE "ADER" TELEPHONE RECEIVER (12)

(For Description See Opposite Page)

Making a Six-Foot Piano Lamp

THE piano lamp here described may, of course, be constructed to suit the fancy of the individual as to finish and design. The finish desired will alter the kind of wood to be obtained. For a mahogany finish either birch or whitewood may be used as substitute for genuine mahogany. I used whitewood and the result was entirely satisfactory, both as to the finish it took and the ease with which it was worked. In the following explanation I will describe the lamp as I built it, but as aforesaid the design may be altered without difficulty.

What Is More Graceful and Pleasing Than a Reading or Piano Lamp of This Style? Full Details for Turning the Wooden Column, Wiring the Lamps, Connection Cord, Etc., Are Given Herein.

WOODWORK DETAILS.

Material—Two pieces 2"x4"x5'x6". One piece 12" square by 3" thick.

Plane one 4" side of each 2"x4". Running lengthwise thru the center of each of the planed sides cut a groove ½" wide and ¼" deep. These grooves extend to within two inches of each end (Fig. 1). (Grooves may best be made with a dado saw.)

Now glue the pieces together, planed sides next to each other. You now have a piece 4"x4"x5'6" with a hole ½" square extending thru the center to within two inches of each end. (When gluing be careful that no glue laps over into the center hole.)

When the glue is thoroly dry the piece is ready for turning. The two inches of solid wood at each end affords a grip for the head and tail pieces of the lathe. Fig. 2 shows the piece ready for turning and the dotted lines show it as it will be when it is turned up. (Observe dimensions carefully.)

After it is turned and smoothed with fine sandpaper, remove from the lathe and cut off at A and B (Fig. 2). It will then resemble the dotted lines in Fig. 2 and the hole will extend completely thru the post. Now cut off one-half inch from AF (Fig. 2).

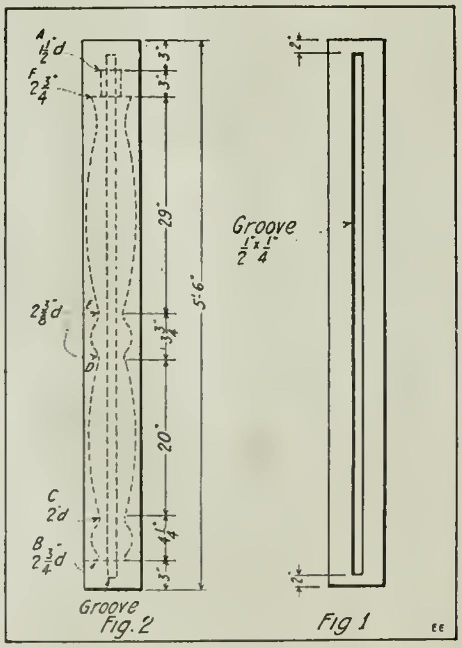
For the base take the 12"x12" piece and cut out a circular piece with as large a diameter as possible. Screw this onto a face-plate and insert in a lathe for turning. Fig. 3 shows the pattern. A hole 1½" in diameter is bored thru the center of the piece. Another hole (A-Fig. 3) ⅜" in diameter is bored from the edge of the base to the inside hole and parallel to the bottom.

We will now leave the woodwork and turn our attention to the electrical details.

ELECTRICAL DETAILS.

Material—1 brass piece A-Fig. 4; 1 brass nipple to fit threads in the bottom of the brass piece (B-Fig. 4); 1 brass flange to fit the nipple (C-Fig. 4); 1 attachment plug; 2 brass pull-chain sockets (D & D Fig. 4); 11 feet of silk covered two-wire lamp cord.

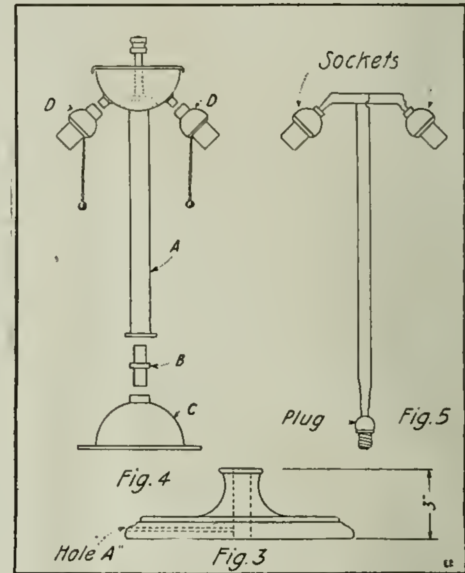
The brass piece (A Fig. 4) is made especially for the purpose. I found it at a hardware store that deals largely in lamps. It consists of a heavy brass tube tapt at the lower end and fitted at the upper with a piece as shown in the figure, from which two nipples extend to screw the sockets onto. This upper part is hollow to provide a place to make connections. Up thru the center of the cup thus formed and extending some distance above the top, is a rod threaded at the upper end and fitted with a nut. The cup is also provided with a cap with a hole in the center to pass the upright rod.



Clever Method of Making the Turned Lamp Column from Two Pieces of Thin Stock Glued Together.

I took the above piece to an electrical supply house and had the nipple and flange fitted to the bottom.

The plug is either a crew plug or one that has two prongs which fit into slots in the socket.



Arrangement of Lamp Sockets, Wiring Diagram and Detail of Turned Wooden Base With Hole for Connecting Cord.

The chains on the sockets will probably be too long. To remedy this screw both sockets onto the nipples on the post and set the post on top of the wooden post. You will then see how much too long the chains are and how many beads it will be necessary to take off. Now remove the sockets and dis-assemble each. Take the inside part and you will observe that the chain runs thru a short tube and over a small drum. At the end of the drum the end bead of the chain fits into a slot. Remove the chain from the slot and take off as many beads as you wish. When this is done put what is now the end link of the chain into the slot and reassemble the socket.

The cord may be obtained in brown, red, or green. A color should be chosen that will look well with the shade you select.

ASSEMBLING.

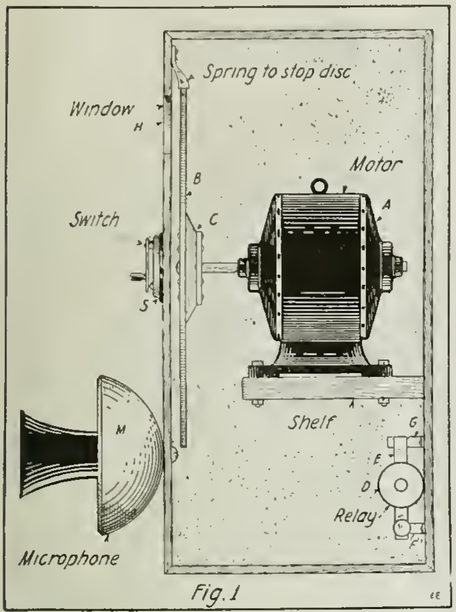
Pass one end of the twin conductor lamp cord thru hole A in foot (Fig. 3), and up thru the large one. Then pass it up thru the hole in the vertical column. Now cut off about six inches of the end of the cord, remove the outside silk covering and the cotton covering of each wire leaving two six-inch rubber covered wires. Take one of the sockets apart and screw the top part onto one of the nipples on piece A (Fig. 4) and lock it with the set screw provided. Remove the rubber from each end of each of the six inch wires. Pass an end of each wire thru the nipple and top of the socket.

(*Continued on page* 210)

An Electric Oracle

By THOMAS W. BENJAMIN

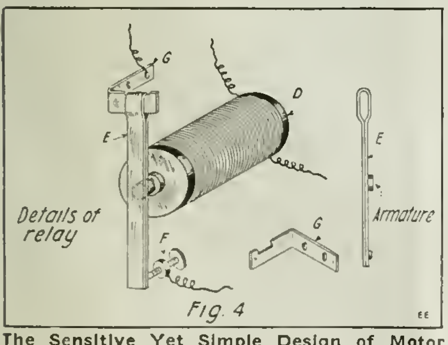
THE power is not given to all persons, or for that matter to any person, to look into the future and see what is in store for them. Still quite a lot of amusement may be obtained from the electrical instru-



Mystery Is the Keynote of All Successful Puzzles and Games. It Is Also the Leading Card In the Deck of Surprise Answers Given by this Electric "Oracle." Ask It a Question and the "Answer" Appears Before You.

ment described herewith that purports to tell of events to come. Those who are particularly superstitious will treat the device with awe till it springs a joke on them.

It consists essentially of a box containing a small battery motor and a sensitive relay, the latter being controlled by a microphone mounted on the front. When a question is spoken into the microphone it will cause the relay to close for a certain length of time and start the motor. The latter has fastened on its shaft a disk of cardboard or thin metal that has a series of answers written on one side. An opening in the front of the box allows these answers to be viewed. Naturally after the disk stops revolving, the answer directly under the opening is the reply to the question asked the device.



The Sensitive Yet Simple Design of Motor Control Relay Used In the Electric "Oracle."

The fact that they are ridiculous at times makes the apparatus all the more interesting.

The construction is simple and the details can be seen in the attached illustrations. At Fig. 1 is shown a side view of the device. At A is a small battery motor mounted on a shelf. The cardboard or tin disk is shown at B, and is mounted on the motor shaft by means of a wood disk C, which may be cut from a small spool.

The window H allows the answers on the disk to be viewed. The window may be of any convenient size and covered with glass if desired. After determining the width of the window, the face of the disk should be divided up in a number of parts of the same width.

Inside these divisions the "answers" are written or printed by means of a pen. The edge of the disk is nicked between each answer and a light spring attached to the front of the box bears against the edge of the disk and dropping into the notches will stop the disk with a reply directly under the window.

The microphone on the front may be a regular telephone transmitter. The relay can be easily made by following the details shown in Fig. 4. The magnet can be taken from a high-resistance polarized ringer, the armature is a strip of brass bent into a loop at one end and placed over the support G, bent as shown. An iron piece is riveted on opposite the magnet. The contact F is supported by a brass standard and makes contact with the brass strip when the magnet attracts it.

The complete wiring diagram is illustrated at Fig. 5. The switch S, serves to open the two circuits when the apparatus is not in use. Two binding posts are provided to which two handles are connected. These posts are shunted across the "break" of the relay and in addition to adding to the mystery of the device, will at times give the person holding them a slight shock, due to the reactance of the motor. They likewise reduce sparking at the contacts.

To use the oracle, close switch S and grasp the handles. Holding the mouth about two inches from the mouth piece of the transmitter, speak clearly and distinctly into the transmitter. The disk will start to spin and stopping, will give the answer to the question asked. The replies may consist of any words, for instance, "Certainly," "Yes," "No," "How Foolish," "Of Course Not," "Without a Doubt," "Act Sensible," etc.

A RELIABLE WEATHER GLASS

A test tube about 10 inches long and ¾ inch in diameter is fastened to a base or hung up by a wire. In this test tube are put 2 drams of camphor, ½ dram of potassium nitrat, ½ dram of ammonium chlorid, 2 ounces of pure alcohol, 2 ounces of water. If the ingredients do not mix easily, tube should be put in warm water or shaken thoroly. After a cork is put in the tube, it is ready for work.

Following is the weather, which the changes in the liquid denote:

Clear liquid—Bright weather.

Crystals at bottom—Thick air, frost in winter.

Dim liquid—Rain.

Dim liquid with small stars—Thunderstorms.

Large flakes—Heavy air, overcast sky; snow in winter.

Threads in upper part—Wi dy weather.

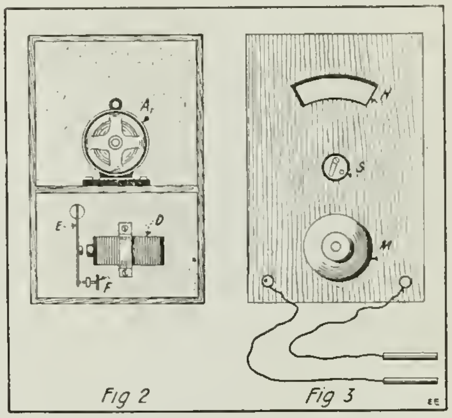
Small dots—Damp weather, fog.

Rising flakes which remain high—Wind in upper air.

Small stars in winter on bright, clear, sunny days—Snow in a day or two.

Contributed by

GEORGE EDWIN SPITZMILLER.

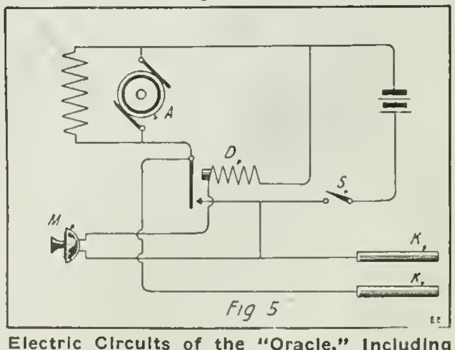


Front View and Interior View With Cover Removed, Showing the Simple Motor and Control Relay of the Electric "Oracle."

INVESTIGATION OF INDUCTANCE COILS.

Extensive research on the inductance and resistance of standard coils at different frequencies has been carried out at the Bureau of Standards. A careful study has been made of the factors which cause the inductance of a coil to decrease and the resistance to increase with increasing frequency of current. The most important of these are (1) electrostatic capacity between the windings, (2) energy loss in the insulating material caused by dielectric hysteresis, (3) skin effect in the conductors, and (4) eddy currents in neighboring masses of metal. The effect of all of these can be reduced by proper design.

A large number of coils have been constructed and measurements made to determine the change of resistance and inductance with frequency. Methods have been devised for determining the effect of each of the factors enumerated above on these coils. The experimental determination of the skin effect has been found most difficult. In order to check the experimental values on skin effect theoretical formulas are needed. At present the only satis-



Electric Circuits of the "Oracle," Including a Shocking Circuit Provided With Metal Handles, So That the Mysticism Produced May Be Still Further Deepened In the Minds of the Uninitiated.

factory formulas are those which apply to a straight wire. By means of a new method other formulas are being developed.

A Reversing Switch for Small Motors

By ALLEN Q. SJOHOLM

NO doubt many of the readers of this magazine are owners and operators of small low-voltage motors. Some of these motors have already been provided with reversing switches by the manufacturer, but the majority are not so well off. I present, herewith, details for the construction of such a switch.

This switch is of convenient size; it is simple in construction and operation; it may be mounted on a switchboard or it may be used wherever the motor is located.

The wooden pieces of this instrument are all of ¼-inch oak or any such hard wood. They should be well planed and sanded if you wish a neat-appearing instrument.

The base or back is four inches square. All the edges have a ⅛-inch chamfer. A larger one will not look well. Holes may be drilled near the edge so that the instrument may be fastened to the switchboard if so desired.

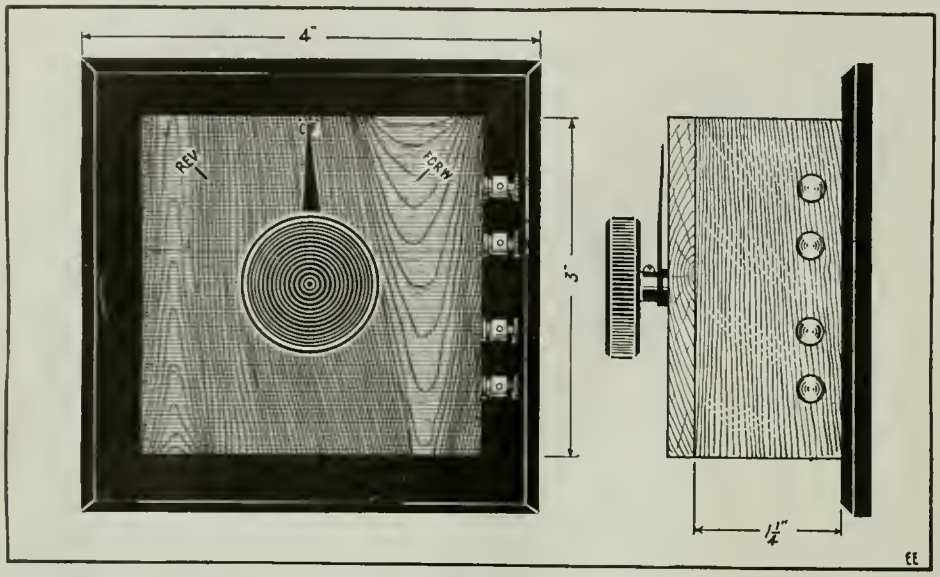
The top of the box that fits on the base is 2½ inches by 1¼ inches. It has a groove, cut lengthwise thru the middle, ¼ inch wide, ⅛ inch deep, continuing the whole length of the top. On the base side of the groove are four holes to receive binding posts. The bottom is exactly the same as the top, except in that it has no holes for binding posts.

The sides are 3 inches by 1¼ inches; they are without grooves. For reasons that will be explained later, they are fastened to the other parts by screws, not nails.

The front piece is 3 inches square. In the center is a hole large enough for the shaft to turn in easily. The location of the points "forward," "off" and "reverse" may be found in the drawings.

The inner base is 2½ inches by 2¾ inches. It must be made thin enough to fit in the grooves in the top and bottom. Like the front piece, it has a hole of the same size in the center. Located on a circle 1½ inches in diameter are four holes to receive switch points. These holes are placed so as to form a square whose sides are parallel to the sides of the box.

The movable part is of fiber ⅛ inch thick. On the side facing the inner base are fastened two circular pieces of sheet brass or copper as indicated. The lengthwise center of these strips must lie on a circle, 1½ inches in diameter (see drawing). They must be in the form of an arc of a circle 1½ inches in diameter. They should be at least ¼ inch wide. Their ends must be at any rate ½ inch apart and not more than ⅝ inch apart (see drawing).



Front and Side View of Small Motor Reversing Switch Here Described. It Has But Very Little Movement and This Feature Alone Will Commend It to Every Experimenter. It Is Also Small In Size and Lends Itself Well to Many Different Purposes.

The shaft or shank can be made from a nail; about an eight-penny. It is first cut to the required length. The shaft passes thru the hole in the center of the inner base; thru the movable part, and thru the front piece. To make it work more easily, a washer is placed between the head of the nail and the inner base. A washer placed between the pointer and the front piece would work to good advantage. The shaft is securely fastened to the movable piece, the pointer, and the knob. However, it must turn freely in the hole in the inner base and the front piece. The knob on the end of the shaft should be a typewriter knob, preferably. This type of knob can be fastened to the shaft more securely than any other kind. Also it can be removed more easily.

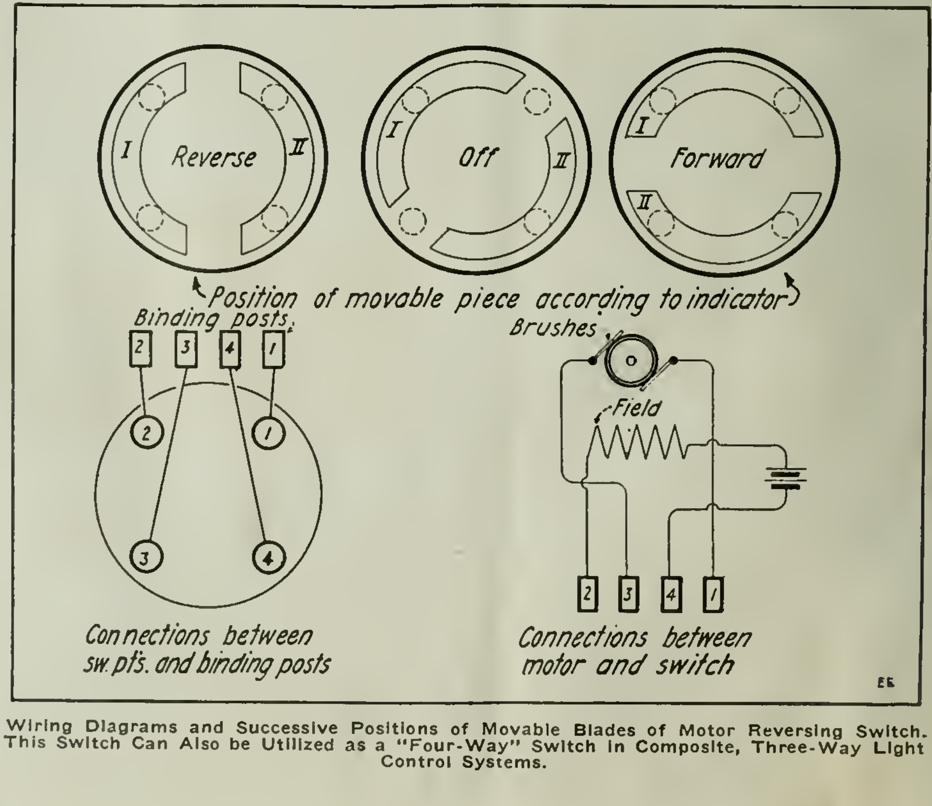
It will not be hard for the constructor to assemble this instrument, but he must observe at least two things: First, he must see that the brass strips are in good contact with the switch points, and, second, that the indicator and movable piece agree. The reason for fastening the sides by screws is this: If something should go wrong inside the box, only the sides need to be removed in order to get at it.

The various positions of the movable piece according to the indicator are found in the drawings. All connections can be made more easily from the drawings, so I will omit them here.

The constructor can stain or paint his instrument any color that he may desire. If he does not, it should at least receive a coat of shellac.

It is a very good plan for the constructor to paste or cut the numbers of the binding posts on the top. These numbers will be found in the drawings. To save time and trouble, a diagram of the connections from the switch to the motor should be fastened to some convenient place on the instrument. This diagram will also be found in the drawings.

This design of switch lends itself to many other problems besides that of reversing motors. It can be used effectively in three-way lamp control systems in conjunction with the usual type of three-way switches. It serves as a four-way switch.



Wiring Diagrams and Successive Positions of Movable Blades of Motor Reversing Switch. This Switch Can Also be Utilized as a "Four-Way" Switch in Composite, Three-Way Light Control Systems.

Needless to say, if the directions are carefully followed, the constructor can expect a good reversing switch as the result of his labor, troubles, etc. And he will find plenty of both if he isn't careful. So "Safety First."

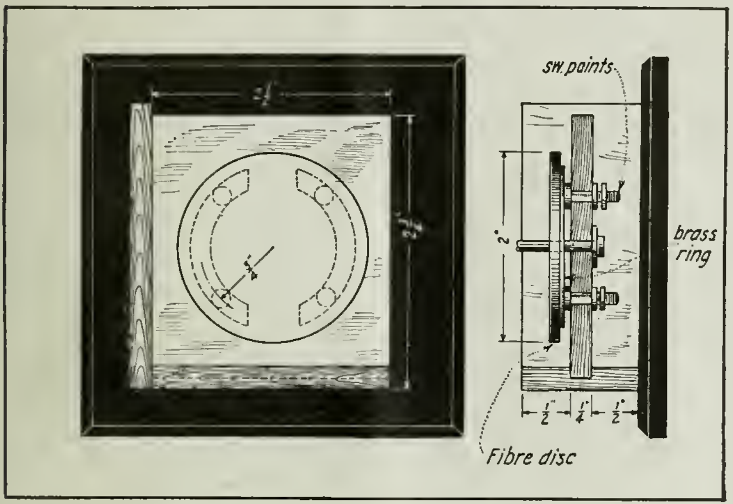
DEPOSITING SILVER ON GLASS.

The experiment which I am about to describe has three uses: It shows a test for cream of tartar; to prepare Leyden jars for copper plating; it illustrates the principle of silvering mirrors.

Begin with a test tube or a thin glass vessel that is scrupulously clean. In this proceed to make a fairly concentrated solution of silver nitrat ($AgNO_3$), which is procurable at any drug store. To this add a little ammonium hydroxid (NH_4OH) and some cream of tartar (baking powder). Now warm until a deposit of silver forms on the walls of the vessel.

Nothing ever found in baking powder except cream of tartar will cause silver to precipitate from a solution of silver nitrat and ammonium hydroxid, so by means of this experiment one might test baking powder for the presence of cream of tartar. Then a silver deposit formed in this manner could be used as a basis for plating copper on a jar to make a condenser. A mirror can be made by warming a small piece of glass and flowing over it a solution of the constituents previously mentioned.

Contributed by
SHERMAN S. GARRETT.



Front and Side View of Handy Reversing Switch for Small Motors, Lamp Circuits, and Dozens of Other Problems Besetting Every Electrical "Bug."

Years ago many an experimenter would try to make a sail boat move by a fair "wind" produced by a huge bellows mounted on the stern of the boat. It was found impossible because the *reaction* on the bellows was equal to the action on the sail.

It pays to study mathematics, for with its aid one is enabled to solve some of the most mystifying things that occur in science.

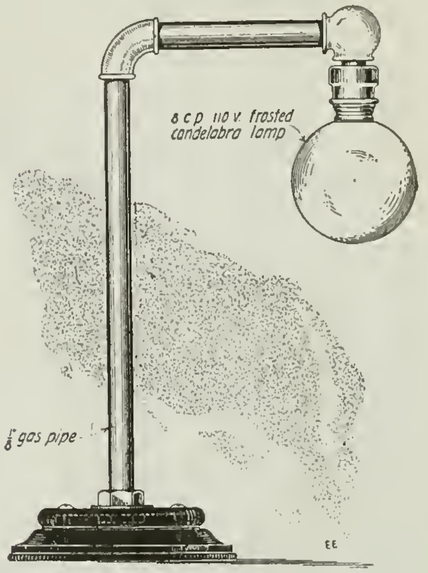
AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

A HOME-MADE READING LAMP.

When drawing or reading, a good light is often necessary nearby. A reading lamp may be easily made from some old gas piping and odd parts, which tho not quite ornamental enough to adorn your library, will serve very well when you are "burning the midnight juice" in your den, trying to solve "trig" problems.

The base of the lamp is made of a rather heavy paper weight which has a few ornamental beads turned on it for appearance. On the top of this an old switch base is fastened with two machine screws, which thread into holes in the paper weight tapt for that purpose. The weight should be at least 4" in diameter.



A Home-Made Electric Reading Lamp Constructed from Some Pipe, a Wooden Base and a Lamp Socket.

A piece of ⅛" gas pipe 8½" long is then fastened to the switch base by two gas pipe nuts on either side of the switch base. The illustration shows the top nut as well as the bottom nut which fits into the hollow of the switch base. An elbow is screwed into the top of the pipe carrying another 2" piece of pipe.

This short piece has at its other end the sort of elbow usually used on gas lines at the burner. A standard candelabra socket is screwed into this elbow. The wiring is carried down into the base where it connects with flexible cord and connecting plug and is let out of the base by a ¼" hole diametrically thru the paper weight. An 8 c.p., 110-volt, frosted, candelabra bulb will be found very satisfactory, not hurting the eyes and giving a good illumination. The whole lamp may be painted with black paint, such as Japalac, which adds considerably to its appearance.

Contributed by
ALBERT H. BEILER.

CAT SHOCKER.

Many a night when you were just about going into the land of dreams you were prevented from further enjoyment by musical echos in your back yard academy. I have devised a way to stop "Tom" from making his nightly debut on your back yard fence, and it will now be up to him to hire another hall.

Most amateurs are not using their coils at present and are at a loss to know what to do with them. I will tell you. Cut up several pieces of tin 2" x 3", 12 or 14 will do, and nail them along the top of your fence, separating them about 8 or 10 inches. Now run two well insulated wires along the side of the fence. These should be connected to the secondary terminals of the spark coil. Connect them as described in diagram and you won't be bothered with any more feline opera concerts. When "Tom" gets his two front feet on one strip and his back feet on the other, press your key and "Tom" will see stars.

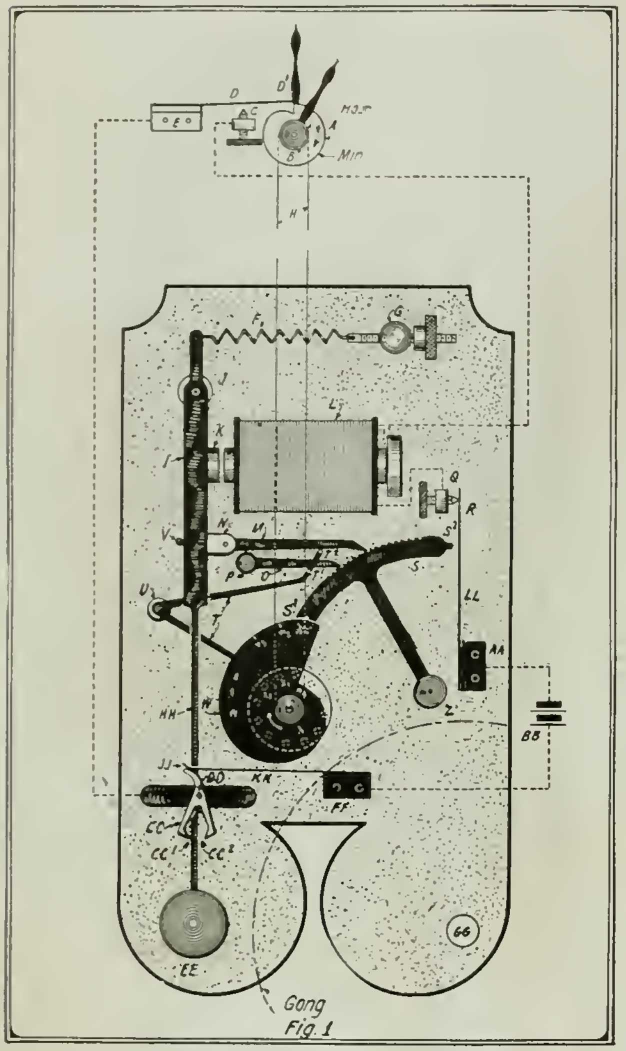
Contributed by FRANCIS ZIESSE.

Do You Own a Spark Coil? If So, Then "Cat Concerts" on the Back-Yard Fence at Midnight Are Soon Brought to a Grand Finale. Hook Up the Coil With Some Tin Plates Scattered Along the Fence. The Spark Coil Will Do the Rest.

An Electric Hour-Striking Mechanism

By THOMAS REED

AN earnest "Bug," who had evidently just completed an electric clock according to specifications, wrote me asking how to make a striking-mechanism to go with it.



Well, Clock Fiends, Did You Ever Attempt to Make an Electric Hour-Striking Mechanism to Attach on That Hall Clock? At Any Rate, Mr. Reed Assures Us, It's No Cinch to Solve the Problem RIGHT, But the Scheme Suggested Here Is Said to Do That Little Job, and Do It O.K. Here's Wishing You Luck.

I had to reply sadly that I didn't know. I said I'd devoted, first and last, a large part of a misspent life to that very problem, and hadn't solved it yet, nor heard of anyone who had. It's a thing that looks as simple as fixing the back gate, till you come to tackle it, when you find some goblin of mechanical perversity lurking at every turn, with a kibosh in his hand, ready to put it on you.

Lots of people have thought they had a successful electric striker, but their rinktums weren't reliable. A few years ago, an inventor was so sure of his, that he approached our firm for $50,000 capital to put it on the market. It was my job to interview him.

He set his clock up on my desk, and started it going. It was nicely made, with a beautiful mahogany case, and he eyed it with the same glance a mother gives her newborn baby boy. He took half an our to describe its perfections, and by that time it was three o'clock.

"Now," said he, "it's going to strike." It did; Ye Gods, it did. It struck the three, and then went on to get all its striking done up for the day. The inventor, his face a beautiful pink, thumped on the case to remind the mechanism of its duty, but nothing doing. At the twenty-seventh stroke, his endurance gave way, and he stopt it by poking a finger in the works.

It was a dirty trick for baby to play, just when papa's $50,000 depended on his speaking his piece right. Sometimes clocks are almost human.

Well now, to return to that "Bug," his letter seemed to bring a sort of inspiration with it; and after telling him dolefully to save the problem, with perpetual motion, to think over at night as a cure for insomnia, an answer to it happened along just as casually and naturally as a fellow dropping in to cut off your gas meter for arrears. So as the "Bug" (whose name was Walter Franseen) furnished the inspiration, he is hereby declared joint inventor of the apparatus, which is shown in Fig. 1.

To begin with, while this mechanism could be incorporated with the time-works, it's better to drop it down below, and connect it with the hour-hand arbor by chain and chain-wheels, or even pulleys and a rubber band, as there is almost no power to be transmitted. In that way, you can have the pleasure of seeing it go; and if it cuts up any shines, as the baby boy did, you can get at it handily with a half brick or a hammer.

As the picture is drawn, the clock is just ready to strike one. The cam *A*, attached to the *minute*-hand arbor of the clock, and moving in the direction indicated, is about to let drop the flat spring *D*, which rests on the cam at D^1.

When the spring does drop, the point on it where the *D* is marked strikes on the contact point *C* and completes the entire electrical circuit. Follow it around. It first enters the little forked trigger *CC*. The bent top of this trigger forms a contact with the flat spring *KK* at the point *JJ*. On goes the circuit, thru the battery *BB*, support *AA*, spring *LL*, across to contact *Q* at point *R*, thru the magnet *L*, and so back to *C*, where we began.

Now, what happens? The magnet *L*, of course, is energized and pulls toward itself the armature *K*, attached to the lever *I*, pivoted at *J*, which carries the heavy hammer *EE* by its stem *HH*. Righto! But also attached to the lever *I* is the stud *N*, carrying the pawl *M*. As this pawl is pushed to the right, it pushes along the circular rack *S*, till just as the hammer strikes the gong, it has pushed it to the extent of exactly one tooth; and the click *O* is holding that gain of one tooth, and will hold it till we get ready to make it let go.

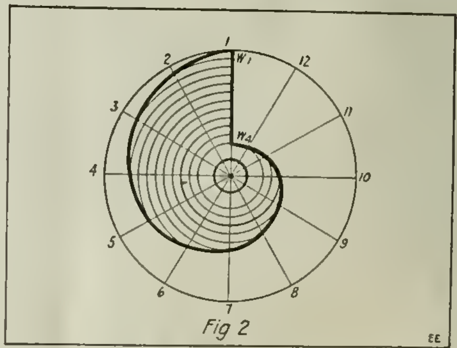
Now, having struck our one o'clock on the gong, we want to stop things. Up above, in the clock-works, of course the contact *D*, *C*, is still closed; it won't be separated for 10 or 15 minutes yet, as the cam *A* goes around with the minute-hand. But look at our excellent nubbin S^2, protruding like a sore thumb from the end of the rack *S*. The nubbin has now reached the spring *LL*, pushed against it, and separated the contacts *Q* and *R*. The magnet *L* is "killed," the armature-lever *I* is drawn back to the stop *V* by the spring *F*, and our mechanism goes to sleep till it's time to make preparations for striking "two."

Next, we introduce the volute-shaped piece *W*, well known in the clock-making art as a "snail." This snail is constantly moving in the direction of the arrow, at the same rate as the *hour*-hand of the clock above. Attached to the same arbor, and moving similarly, is the wheel *X*, with twelve projecting pins, X^1, X^2, etc.

Fifteen or twenty minutes after we have so brilliantly struck "one," the pin X^2 strikes the end of the forked lever *T*, pivoted at *U*; and X^2, continuing further, raises *T*. The top fork of *T*, which is naturally raised also, carries the two pins T^1 and T^2, which bear on both the click *O* and the pawl *M*.

We left Mr. Click holding up the rack *S*, and resolved to continue holding it or know the reason why. Well, the reason is here. On a little further raising of *T*, the click is lifted out of the tooth, and the rack *S* falls till the pin S^1 hits somewhere on the edge of the snail. The snail, however, has been moving to the right, and the pin falls at the point W^2, where the diameter has lessened by just the amount of one rack-tooth. Two teeth in all, then, are ready for our next *hour-strike*.

A few minutes more, and the pin X^3 drops the lever *T*, and the latter "passes the buck" by dropping the click and pawl into the rack, ready for operation. It must be remembered that when the rack *S* fell, it released the spring *LL*, and closed the contact *Q*, *R*; but long before this, the contact *D*, *C*, back in the clock was opened, so we don't start yet. But we are all set again, and the instant *DC* is closed, the striking-operation is repeated; only now the rack *S* has two teeth to go before the



How the Volute-Shaped Disc, or "Snail" as Clockmakers Call It, Is Laid Out With the Aid of a Drawing Compass.

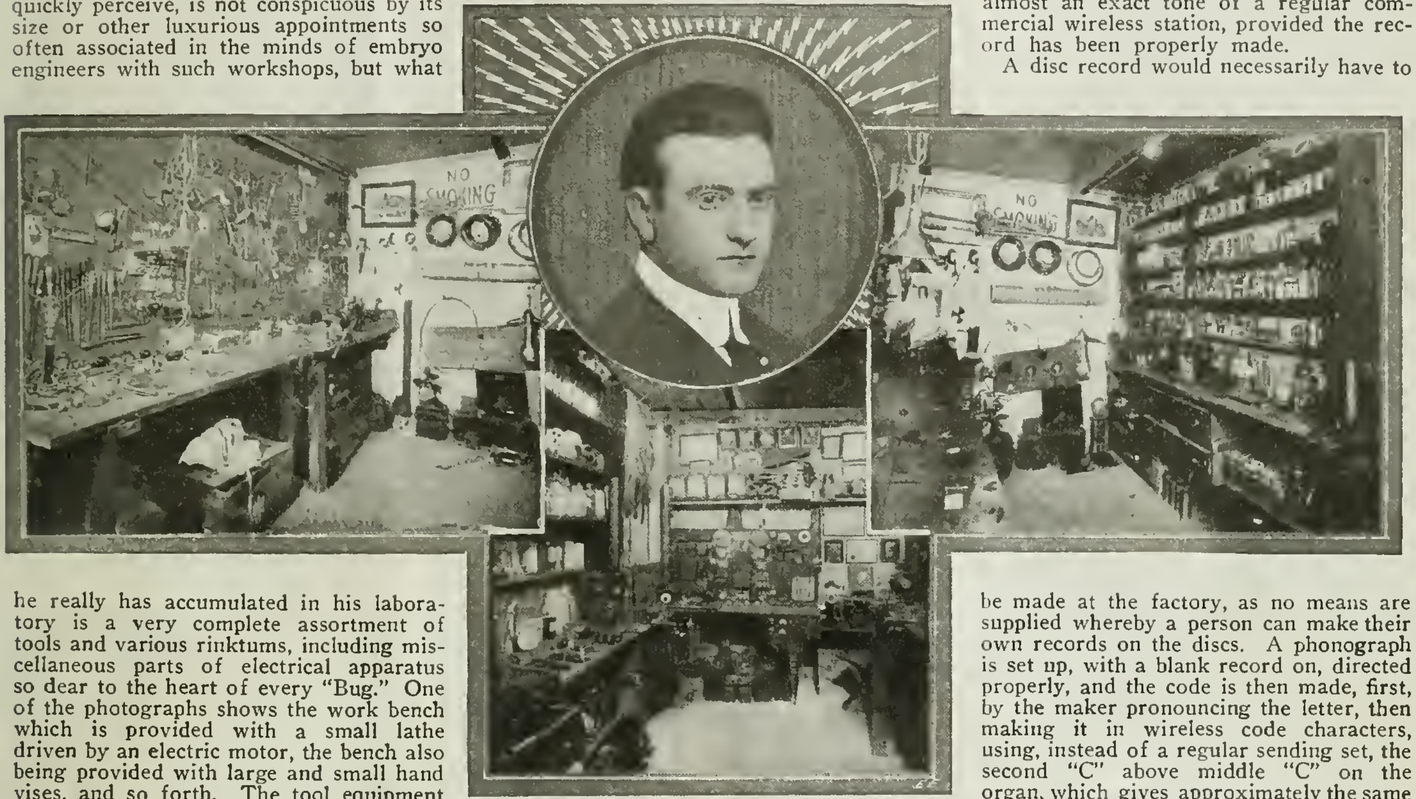
(*Continued on page* 210)

Electrical Laboratory Contest

(Special Prize $5.00)

Experimental Laboratory of John E. Woodrow

THE accompanying photographs illustrate one of the most interesting, real dyed-in-the-wool Experimental Laboratories that we have ever had the pleasure of publishing. Mr. Woodrow has recently joined the U. S. Navy like many other illustrious young men thruout the country, who feel that they can do the utmost good for their government by offering their skill and talents to Uncle Sam. This youthful electrical and radio genius hails as his home town, Peoria, Illinois. Mr. Woodrow's laboratory, as the reader will quickly perceive, is not conspicuous by its size or other luxurious appointments so often associated in the minds of embryo engineers with such workshops, but what he really has accumulated in his laboratory is a very complete assortment of tools and various rinktums, including miscellaneous parts of electrical apparatus so dear to the heart of every "Bug." One of the photographs shows the work bench which is provided with a small lathe driven by an electric motor, the bench also being provided with large and small hand vises, and so forth. The tool equipment includes screw drivers and files of all sizes, hack saws, wrenches, hammers, chisels, pliers, brushes, stocks and dies, wire, boxes containing a generous assortment of beloved "junk," machine and wood screws, nuts, washers, etc.



Here's a Regular Experimental Laboratory and It Was All Built Up By an Amateur—Mr. John E. Woodrow, of Peoria, Ill. Note the Complete Assortment of Tools, Chemicals and Electrical Apparatus.

Among the other "high lights" in Mr. Woodrow's excellently equipt laboratory, we find an electric fan, storage batteries, a complete wireless receiving set and various parts of both large and small radio sets, primaries and secondaries for a large Tesla coil, electro-magnets and solenoids, small motors, parts of a Cooper-Hewitt mercury arc rectifier, as well as parts of a motion picture projector.

One part of the laboratory is devoted to "Experimental Chemistry" and contains a large assortment of the various chemicals needed by the experimenter in this branch of science, and as may be seen, the owner of this laboratory keeps his chemicals in well-stoppered bottles and tight-fitting tin cans.

In connection with the chemical and electro-chemical experiments as well as in researches in the field of fluoroscopy, there is provided a considerable assortment of electrical apparatus, including various measuring instruments, such as ammeters and volt-meters, batteries both wet and dry type, motor generators, rheostats of various sizes, galvanometers, X-ray tubes and other special vacuum tubes, small weighing balances, and among several hundred other things, the inevitable supply of father's cigar boxes suitably decorated with highly colored lithographs of the Queen of Sheba, or some other equally famous or possibly infamous celebrity, situated in the social scale as remote as possible from the scientific and idealistic "high-brows" of budding Edisons and Teslas, which fact for some reason we have never been able to fathom. Why doesn't some enterprising cigar manufacturer awake to the fact that there are several hundred thousand live, wide awake electrical and radio "Bugs" in the United States alone, who could boost the sale of any cigar no matter how close its relation might be to the well-known "piece of rope," so long as little Johnny or Thomas can influence his Dad to buy that particular smoke, for the very good reason that he wanted one more cigar box to complete his nest of drawers, each of them decorated with the likeness of some great electrical or scientific personage. Just think of it "Bugs," what a glorious universe this would be, if the powers that reign in the tobacco world, would only take up this suggestion and make it possible for us to obtain a more or less complete collection of the invaluable cigar boxes decorated with the "physog's" of Messrs. Tesla, Edison, Steinmetz and Thompson.

AN INEXPENSIVE AND THORO WAY OF LEARNING RADIO CODES.

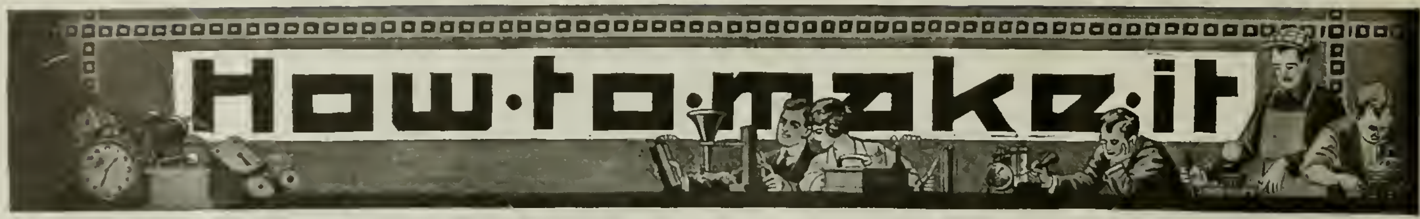
By F. V. CAMPBELL.

The following method of learning wireless codes, without the use of teacher, other than ordinary phonograph, is as follows: In case of an Edison or other cylinder record phonograph, the student can either have a record made by a friend who is competent, or get someone to make it for him, and on reproducing the same, it will give almost an exact tone of a regular commercial wireless station, provided the record has been properly made.

A disc record would necessarily have to be made at the factory, as no means are supplied whereby a person can make their own records on the discs. A phonograph is set up, with a blank record on, directed properly, and the code is then made, first, by the maker pronouncing the letter, then making it in wireless code characters, using, instead of a regular sending set, the second "C" above middle "C" on the organ, which gives approximately the same tone as a standard commercial wireless sending station. Then by word groups or letters, first pronouncing the word, then making it in the code.

The method has been tried out by the writer in learning the Continental code, and has given the most complete satisfaction. The use of the organ in making the record gives a sustained tone pitch, which is essential to wireless receiving, and sounds almost exactly like a commercial station sending. If properly made on a wax cylinder, it will continue to give clear readable signals long after the student has mastered the alphabet from it. A great many persons would like to learn the code who have practically no one to send to them, without which they are at a great disadvantage, but who do possess a phonograph, and at very small expense could either make a record, or secure one from someone who is equipt to make them.

Don't miss the article on "Harmonics—Part II"—by Prof. F. E. Austin, in the August issue of the "Electrical Experimenter." It explains the analysis of irregular shaped alternating curves.



This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**

The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

A NOVEL ALCOHOL LAMP.

Procure six or eight inches of platinum wire, about the hundredth part of an inch in thickness; coil it round a small cylinder ten or twelve times, then drop it on the flame of a spirit lamp, so that part may touch the wick and part remain above it. Light the lamp, and when it has burned a minute or two put it out; the wire will then be ignited, and continue so long as any spirit remains in the lamp.

An Interesting Alcohol Lamp That Burns from a Platinum Wire Spiral Or Piece of Iron Gauze.

Lamps manufactured on this principle are sold by some of the chemists in New York and London.

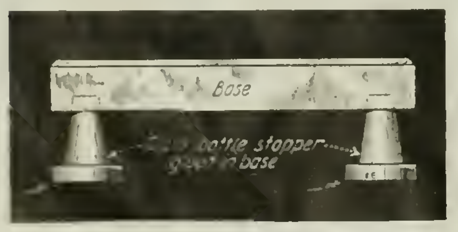
A liquid produced from two solids: Mix equal portions of sulfate of soda and acetate of lead, both in fine powder; let them be well rubbed together in a mortar, when the two solids will operate upon each other, and a fluid will be produced.

A solid produced from two liquids: If a saturated solution of muriate of lime be mixed with a solution of carbonate of potash (both transparent liquids) the result is the formation of an opaque and almost solid mass. If a little nitric acid be added to the product, the solid mass will be changed to a transparent fluid.

Contributed by ELLIOT RABE.

GLASS INSTRUMENT FEET.

It frequently happens that the amateur electrician wants good insulating feet for an instrument. The drawing shows an insulator made from an old glass bottle stopper glued in the base. This makes a very good insulator, being cheap and at the same time serves the purpose.



Instrument Feet from Glass Stoppers.

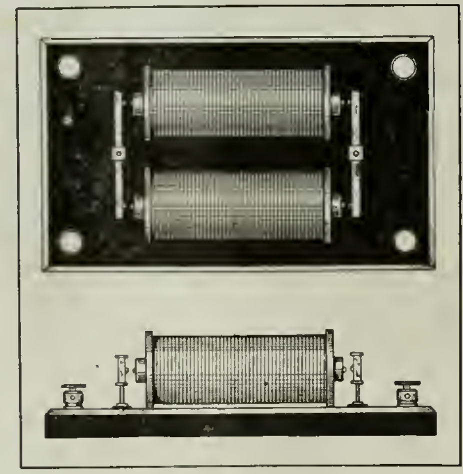
Contributed by E. T. JONES.

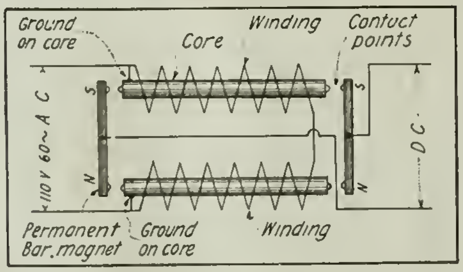
THIRD PRIZE, $1.00

CONSTRUCTION OF NOVEL MAGNETIC RECTIFIER.

The drawing submitted herewith shows the construction of a magnetic rectifier that uses the whole cycle of the A. C. current all the time, which results in a current almost as steady as from a storage battery. The rectifier is made as follows: The coils are both wound in the same direction. Wire required, 1,000 feet, No. 30 S. S. C. wound on each core. The cores measure 2 inches long by 3/8 inches diameter and are preferably made of soft iron wires.

Two bar magnets are pivoted in the center and placed as close as possible to the cores without touching them. One side of A. C. line is grounded on one core, the other side of line to the other core. The D. C. is taken from each pivot that holds permanent magnets. The permanent magnets should have like poles facing each other. The size of wire given is for 110 volt A. C. circuits. I have used this scheme and found it very satisfactory.





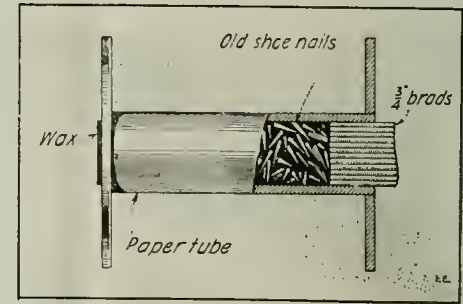
Here's a Simple Form of A. C. Rectifier That Will Appeal to Amateur Electricians.

Contributed by EMIL CAPPELLE.

SECOND PRIZE, $2.00

OLD "SHOE NAILS" MAKE GOOD CORES.

Of course a "bug" can use old "shoe nails." I have used them myself as the "makings" of a laminated iron core for a small induction coil, together with some 3/4" brads. This sketch shows how the wax was used to hold them in. The nails may be annealed by heating to a dull red and then allowed to cool slowly before placing in the tube.



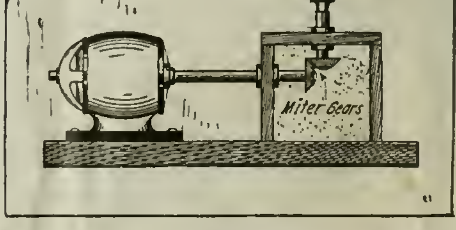
The More We Divide Up An Iron Core Or "Laminate" It, the Quicker It Demagnetizes. Behold the "Shoe Nail" Magnet Core.

Contributed by HARRY W. DRYDEN, Jr.

A MOTOR-DRIVEN SCREW DRIVER SAVES TIME.

A handy and practical screw driver, operated by a motor, will more than pay for itself in a short time. An electric motor is fastened at the left side of a base of wood. A small wooden structure at the right side is built of posts and a small hole is drilled at the top, to admit and allow the free movement of the steel shaft with the chuck. An arrangement by which the motor rotates the steel shaft (with chuck) is clearly shown. This device consists of two miter gears on one end of motor shaft and the other on the chuck shaft. A chuck is threaded on the upright shaft, and with a set of bits, drills, taps, etc., very good and quick work can be done with this apparatus.

Contributed by GEORGE M. CROOTE.

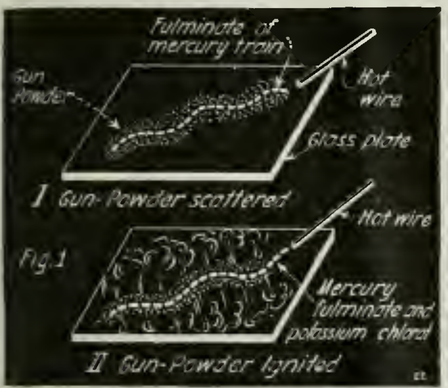


Drive Your Machine and Wood Screws By Motor.

Fulminates—Their Preparation and Properties

By DUNCAN J. THOMSON

MUCH has been written about the guns used in the present European War and it is not out of place to dig down to the root of the whole thing and find out what is the real source of the explosion in the gun chamber. Most guns are set off by means of a *priming cap* and the substance used inside the priming cap is the subject of this article.



Fulminate of Mercury Alone Will Not Ignite Gunpowder. When Mixed With Potassium Chlorat, However, It Readily Ignites the Gunpowder, Due to the Retardation of the Flash and the Heat Formed.

Mercury Fulminate is the active substance in the priming cap. This substance is prepared by the action of alcohol on a solution of mercury dissolved in an excess of nitric acid; and as this action is of a violent character, some care is necessary in order to avoid an explosion. On a small scale, the fulminate may be obtained without any risk by STRICTLY ATTENDING TO THE FOLLOWING DIRECTIONS:

Weigh out, in a watch-glass, 25 grains of mercury, transfer it to a half-pint beaker, add half an ounce (measured) of ordinary concentrated nitric acid (sp. gr. 1.42), and apply a gentle heat. As soon as the last particle of mercury is dissolved, place the beaker upon the table, away from any flame, and pour into it, pretty quickly, *at arm's length*, 5 measured drachms of alcohol (sp. gr. 0.87). Very brisk action will ensue, and the solution will become turbid from the separation of crystals of the fulminate, at the same time evolving very dense white clouds, which have an agreeable odor, due to the presence of nitrous ether, aldehyde, and other products of the action of nitric acid upon alcohol. The heavy character of these clouds is caused by the presence of mercury, tho in what form has not been ascertained; much nitrous oxid and hydrocyanic acid are evolved at the same time. When the action has subsided, the beaker may be filled with water, the fulminate allowed to settle, and the acid liquid poured off. The fulminate is then collected on a filter, washed with water as long as the washings taste acid, and dried by exposure to air.

How to Make a "Throw-Down" Fire-cracker from a Few Quartz Fragments and a Piece of Silver Fulminate, All Wrapt in a Piece of Thin Paper.

On a large industrial scale, the preparation of mercuric fulminate is carried out in the open air, under sheds. At Montreuil, 300 grammes of mercury are dissolved in 3 kilogrammes of colorless nitric acid of sp. gr. 1.4, in the cold. The solution is transferred to a retort, and 2 litres of strong alcohol are added. In the summer no heat is applied, and the vapors are condensed in a receiver and added to a fresh charge. When the action has ceased the contents of the retort are poured into a shallow pan, and when cold, the fulminate is collected in a conical earthen vessel partially plugged at the narrow end. It is washed with rainwater and drained until it contains 20% of water, being stored in that state.

Mercuric fulminate is represented by the formula $HgC_2N_2O_2$, being derived from the hypothetical fulminic acid $H_2C_2N_2O_2$ by the substitution of Hg'' for H_2. Its production by the action of nitric acid upon mercury and alcohol may be explained by the following reactions:

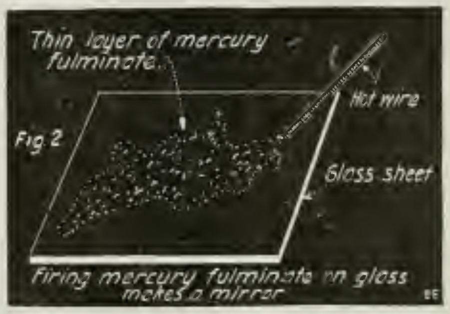
(1) Mercury, dissolved in nitric acid, yields mercuric nitrat and nitrous acid.

(2) Nitrous acid, acting upon alcohol (ethyle hydrat), gives nitrous ether (ethyle nitrit) and water.

(3) Ethyle nitrit, acted on by another molecule of nitrous acid, gives fulminic acid and water.

(4) Mercuric nitrat (formed in the first reactions) may be supposed to act upon the fulminic acid, producing mercuric fulminate and nitric acid.

Properties of *mercuric fulminate*.—This substance is deposited in the above process in fine needle-like crystals, which often have a gray color from the accidental presence of a little metallic mercury. It may be purified by boiling it with water, in which it is sparingly soluble, and allowing the fulminate to crystallize from the filtered solution. Very moderate friction or percussion will cause it to detonate violently, so that it must be kept in a corked bottle lest it should be exploded between the neck and the stopper. It is usually preserved in the wet state, with about one-fifth its weight of water. Its explosion is attended with a bright flash, and with gray fumes of metallic mercury. The violence of the explosion must be attributed to the sudden evolution of a large volume of gas and vapor from a small volume of solid, for the fulminate, being exceedingly heavy (sp. gr. 4.4), occupies a very small space when compared with the gaseous products of its decomposition, especially when the latter are expanded by the heat. One gramme of fulminate evolves 403.5 units of heat, giving an estimated maximum pressure of 48,000 atmospheres. The evolution of heat during the explosion, apparently in contradiction to the rule that heat is absorbed in decomposition, must be ascribed to the circumstance that the heat evolved by the oxidation of the carbon exceeds that absorbed in the decomposition of the fulminate. A temperature of 195 degrees Centigrade explodes fulminate of mercury, and the same result is brought about by touching it with a glass rod dipt in concentrated sulfuric or nitric acid. The *electric spark*, of course, explodes it.



If a Thin Layer of Mercury Fulminate On a Sheet of Glass Is Ignited, Metallic Mercury Will Be Deposited, Thus Forming a Mirror.

Cap composition.—The explosion of mercuric fulminate is so violent and rapid that it is necessary to *moderate* it for percussion caps. For this purpose it is mixed with potassium nitrat or chlorat, the oxidizing property of these salts possibly causing them to be preferred to any merely in-

(*Continued on page* 197)

If Some Fulminate of Mercury Is Heated On a Piece of Copper Foil a Slight Explosion Occurs; With Silver Fulminate a Violent Explosion Results.

Experimental Chemistry

By ALBERT W. WILSDON

Twenty-Sixth Lesson

CARBON DIOXID.

Experiment No. 133.

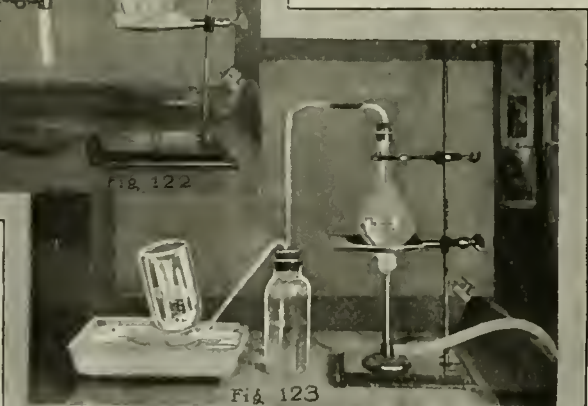
Preparation from Calcium Carbonate and Hydrochloric Acid.

HAVE (1) a splint; (2) 10 cc. of limewater in a test tube; (3) 10 cc. of blue litmus solution in another tube; (4) 10 cc. of barium hydroxid in a third tube. These should be ready to apply the several tests while the experiment is under way.

Either an Erlenmeyer flask of about 250 cc. or a wide-mouth bottle may be employed for the generator (see Fig. 121). Arrange the thistle and delivery tubes in the two-hole rubber stopper as shown, carrying the delivery tube at right angles into the receiving bottle. Put into the generator 20 or 25 grams of marble chips ($CaCO_3$) and cover with water, which serves to dilute the acid, which is next poured in thru the thistle tube, a little at a time, but enough to insure good action. First collect some of the gas by downward displacement in a wide-mouthed bottle that may be left open. When action is well under way, light the splint, and thrust it into the receiving bottle. Repeat this several times, and determine whether or not it is combustible or non-combustible; or a supporter or non-supporter of combustion.

Above — Set-up of Apparatus Used in Experiment No. 133, for the Generation of Carbon Dioxid from Marble Chips and Hydrochloric Acid.

Below — Different Arrangement of Calcium Carbonate and Hydrochloric Acid Apparatus for Producing Carbon Dioxid, the Gas Passing into a Test Solution in a Test Tube as Shown.



Below—Apparatus Used in the Preparation of Carbon Monoxid from the Action of Sulfuric Acid on Oxalic Acid Crystals.

The equation taking place in the generator is:

$$(1)\quad CaCO_3 + 2HCl = CaCl_2 + H_2CO_3$$
$$(2)\quad H_2CO_3 = H_2O + CO_2$$

Now place the delivery tube in the blue litmus solution and permit the gas to bubble thru it. What action do you notice? Further try its solubility by passing some into plain water and then testing the water with litmus paper. From these tests, does it suggest that the gas combines with the water or not? The gas may also be tested by trying to collect some over water and noting the rapidity with which it goes thru the water.

Allow the gas to bubble thru the prepared limewater (calcium hydroxid) and note the familiar effect. Permit the bubbling to continue. The precipitat should gradually dissolve. What could cause this paradoxical result? After the lime in this water solution is all combined and precipitated, what would become of the surplus carbon dioxid? Knowing that most acids act on carbonates and dissolve them, if the product of that action is a soluble substance, can you explain the disappearance of the precipitat? Assuming the substance formed to be $H_2Ca(CO_3)_2$, try and write the equation. Now boil the newly formed solution in the tube and note again the result. Is it what you would expect? What do you conclude has caused this new effect? Is the substance the same you had at first?

Apply to the barium hydroxid solution the same tests as to the calcium hydroxid and explain it, with your equations.

Experiment No. 134.

For the following experiments it is advisable to have a Florence flask fitted with a two-hole rubber stopper, carrying a thistle and delivery tube (see Fig. 122), and not to use over 10 grams of the carbonat, which is then covered with water and the acid poured in in small successive amounts, the delivery tube going over into the solution to be used as a test. Employ the limewater, the barium hydroxid, litmus, and combustion tests. In this manner try the action of nitric acid and on calcium carbonat; also try sulfuric acid, separately on calcium carbonat. Make full notes of each, including tests and equations.

Next take some sodium carbonat in each of three tubes and act on it with the three acids (each in a different tube) hydrochloric, nitric and sulfuric, making full notes as before.

Use potassium carbonat with the same acids in like manner.

What general conclusion can you draw concerning the method of preparing carbon dioxid? Concerning the action of acids generally on carbonates? This generalization is of wide application. There are two notable exceptions to it, *i. e.*, hydrocyanic acid and hydrogen sulfid. Carbonates in respect to the action of acids come the nearest to hydrates or bases of any common salts.

Experiment No. 135.

Production of Carbon Dioxid by Combustion.

Fill a deflagrating spoon with powdered charcoal, heat the charcoal to redness, and let it burn in a covered bottle. Test the gas with limewater.

Hold a dry clean bottle over a *small* gas flame for a few seconds. What product do you notice? Apply the limewater test. What is the second product? Repeat with a candle flame; with burning wood; with the flame of kerosene; of alcohol. The last two flames can be conveniently obtained by dipping a bunch of asbestos into the corresponding liquid, placing it on the base of your stand and igniting it.

Draw your conclusions regarding the existence of carbon in combustibles and the products of their combustion.

Experiment No. 136.

Changes Produced in Air by Respiration.

Place some clean limewater in a beaker and blow gently thru it by means of a glass tube. What is the result? Invert three wide-mouth bottles full of water in your pneumatic trough or tray, and collect air in the first bottle from the *beginning of an expiration.* Withdraw the bottle from the water by means of a glass plate, slip the plate aside for an instant and lower into the bottle a lighted candle. Does it burn as long as it would in the same volume of pure air? Why?

In the second bottle, collect air from the *end of an expiration,* using the *last portions* of air from the lungs. Test this with a candle. What is the result? The result is due partly to the small amount of oxygen, and partly to the large amount of carbon dioxid.

Fill the lungs with air, and hold the breath as long as you can without discomfort. Collect the first of the expiration and test it with a lighted candle. Does the result furnish any evidence of the diffusion of carbon dioxid upward, or of oxygen downward, in the lungs?

The body burns up about 220 grams of carbon in 24 hours, almost all of which is cast out thru the lungs as carbon dioxid.

Experiment No. 137.

HARD WATERS.

From Calcium Hydroxid and Carbon Dioxid, Tested by Soap.

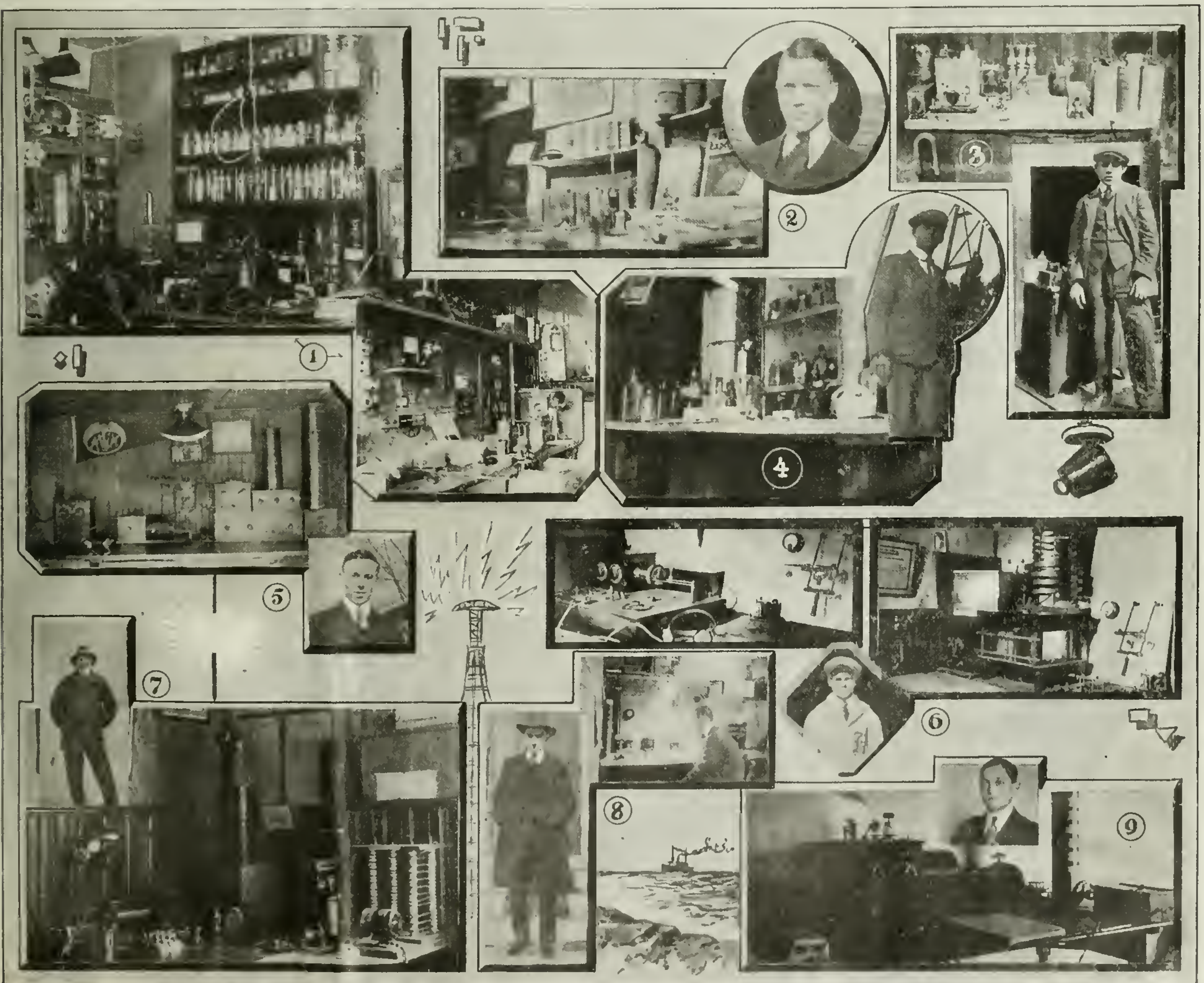
Make a soap solution by dissolving shav-

(*Continued on page* 192)

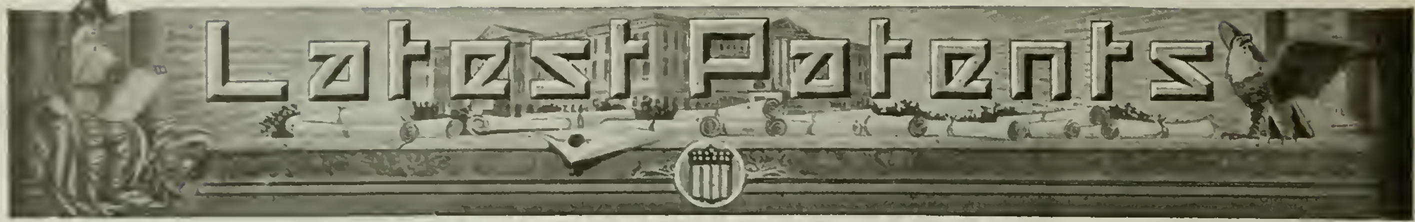
Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay **$3.00** prize each month for the best photo. Address the Editor, "With the Amateurs" Dept.

"Electrical Laboratory" Contest

In this issue we publish an interesting story with excellent photos, describing one Amateur Electrician's experimental laboratory. Now "Bugs"—we want to publish a similar article each month. Here's our proposition: Why not write up your "Electrical Lab.," in not more than 500 words. Dress it up with several good, clear photographs. If we think it good enough we will publish the article in display style and pay you well for it. The remuneration for such articles will range from $5.00 to $10.00. And "Bugs"—don't forget to make your article interesting. Don't write—"I have a voltmeter, an ammeter, a switchboard," etc., *ad infinitum.* For the love of Pete put some punch in it! Tell us what you do with your instruments and apparatus. You don't mean to tell us that every Experimenter does exactly the same thing. "We" know different—but from the general run of such articles which we have received in the past, one would naturally think every "Lab." exactly alike. Remember—send a photo of YOURSELF along. Typewritten articles preferred.

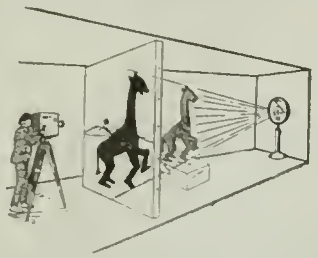


A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.
Electrical Laboratories of, 1—Walter F. Franklin, Brooklyn, N. Y. (Prize Winner); 2—John D. Lawlor, New Bedford, Mass.; 3—Harry Koch, Detroit, Mich.; 4—Harold P. Arnold, West Hanover, Mass.; Radio Laboratories of, 5—Carroll Pfleegor, Milton, Pa.; 6—A. W. Kovatch, Cleveland, Ohio; 8—Arnold S. Rufsvold, Marinette, Wis.; 9—Robert R. Novdstrom, Brooklyn, N. Y.



Animated Shadowgraphs
(1,263,355; issued to Pierre Artigue.)

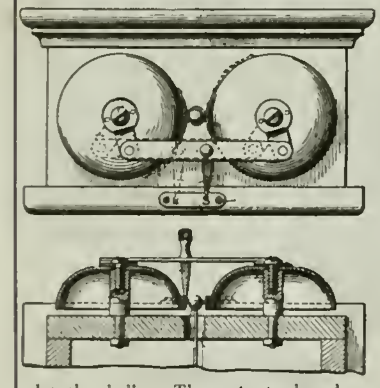
An improved method of producing animated shadowgraphs which in-



volves the use of a powerful electric lamp suitably positioned after the manner illustrated. The screen on which the shadowgraphs are produced has, preferably, painted or otherwise produced thereon a suitable background of trees, buildings or other inanimate bodies. As the moving bodies are in silhouette they conceal the underlying portions of the background, so that these portions will not show thru the solid black of the silhouette as it is projected on the screen.

Adjustable Telephone Bell
(1,260,549; issued to William Kline.)

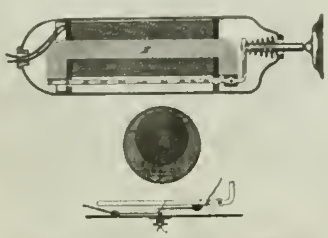
This patent covers a clever arrangement whereby it becomes possible for anyone to readily adjust the strength of the sound given off



by the bells. The patent also describes a novel spiral spring gong, a pair of which can be made adjustable in a similar manner to that described for ordinary bell gongs. For the gongs here illustrated, there is provided a pair of sound dampers, or modulators, consisting of small thin pieces of fiber, felt, celluloid, or other suitable material, which are securely fixt in a specific manner to the outer edge of the bells.

Electric Vibrator
(1,259,396; issued to Albert E. Hartwell.)

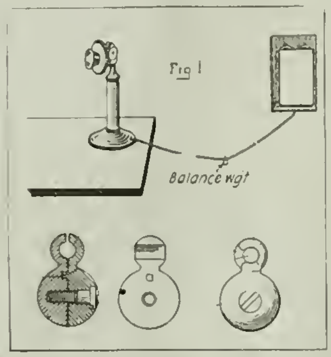
This A. C. type vibrator is extremely simple and consists of an insulated coil with a laminated iron armature core passing thru it, and having an arm pivoted so as to be



vibrated by the alternate energizing and deenergizing of the circuit, and finally said arm having attached to it the massage implement. A spiral spring is secured within the case to act against the pivoted lever arm, so that when the coil is deenergized, this spring will force the arm backward and withdraw the opposite end of the bar from the core.

Non-Twisting Weight for Telephone Cords
(1,259,597; issued to John A. Breen.)

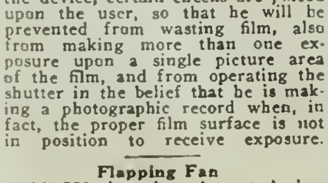
This patent deals with the problem of providing a satisfactory and at the same time cheap form of non-twisting weight for attachment to the flexible cord used on all desk 'phone sets, so as to take up the slack in the cord, and at the same time prevent the cord from twisting; a fault which these cords are un-



happily subject to. The present design provides a non-twisting balance weight which may be attached to or detached from a 'phone cord instantly, without in any way mutilating the cord, and also, without having to disconnect the telephone instrument from the cord. The inventor claims that his device solves the problem correctly, by virtue of the fact that the weight is fixt to the cord upon a different center than that of the cord.

Electric Camera for Reading Meters
(1,260,356; issued to William F. Folmer.)

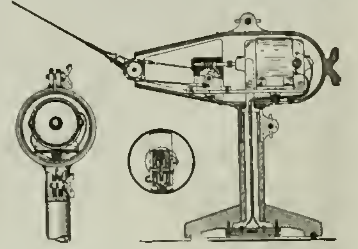
This electrically operated film camera is especially intended for use by gas and electric meter readers, for the purpose of instantaneously photographing the exact reading of the meter dials. The inven-



tor in this case aims to provide a special interlocking arrangement between the film exposing means or shutter and the meter. Illumination lamps are placed in the front of the camera. During the operation of the device, certain checks are placed upon the user, so that he will be prevented from wasting film, also from making more than one exposure upon a single picture area of the film, and from operating the shutter in the belief that he is making a photographic record when, in fact, the proper film surface is not in position to receive exposure.

Flapping Fan
(1,261,753; issued to August Anderson.)

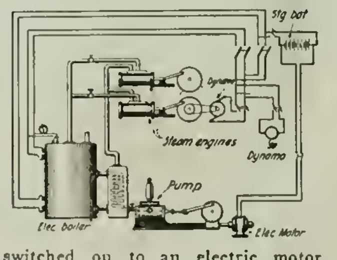
This patent covers a unique form of oscillating electric fan or one in which the blade is made to flap up and down or sidewise as desired, by an ingenious arrangement of an electric motor supported within the



shell-like housing illustrated herewith. A novel driving means is very cleverly worked out, the electric motor being provided with a worm gear, whereby a pair of oppositely disposed arms fastened to the worm wheel rotate continuously and oscillate the fan blade up and down.

Combined Electric Heater and Boiler
(1,258,642; issued to Napoléon Bergeron.)

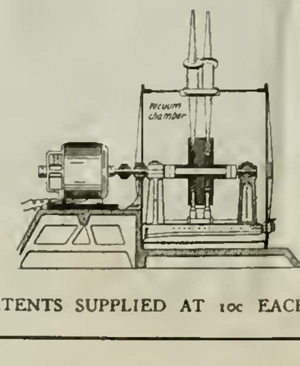
As near as the reviewer can glean from the information given in the patent, the inventor sets out to solve the eternal riddle of "perpetual motion." There is provided to start with, an electric boiler, the steam from which causes a steam-engine to operate; this engine in turn is belted to a dynamo. The current from the dynamo can be



switched on to an electric motor connected with a pump for supplying fresh cold water to the boiler, this water being pre-heated by means of the exhaust steam coming from the steam engines shown. Thus the electric circuits and steam generating apparatus work hand in hand apparently, without any energy from an outside source of electric power being supplied to the electric boiler circuits, except from a small dynamo at "starting."

High Tension Rectifier
(1,259,160; issued to William Walker Strong and Arthur Fleming Nesbit.)

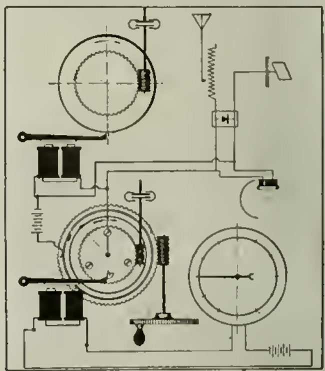
In this rectifier the rotating commutator element is driven by a synchronous motor, and the current rectifier segments and brushes are mounted in a gas-tight chamber, so that the chamber may be filled with compress air or suitable gases under the proper pressure. In order to maintain a suitable gas pressure



within the commutator chamber, there is provided a small pump.

Radio Time Signaling
(1,260,303; issued to Edouard Belin.)

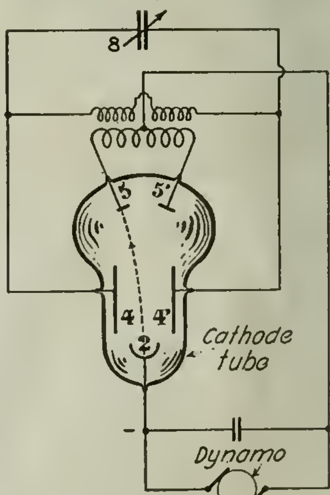
This patent deals with a scheme for bringing apparatus situated at one station in synchronism with that of a main station by either telegraphy or radio, in which case it is necessary to have the apparatus remain absolutely in step at all times, also that it should run at the same speed and should pass thru the same initial point simultaneously. All of these factors the inventor here aims to accomplish. The present invention provides an arrangement for bringing the elements of one or more sub-stations having similar periodic movements into syn-



chronism with that of the main station, and comprises apparatus at each station for correcting each of said elements after intervals of predetermined extent.

Sustained Oscillation Generator
(1,257,971; issued to Joseph Bethenod.)

The single cathode tube here used has a suitable vacuum and carries a cup-shaped electrode at the bottom of the tube, adapted to emit cathode



rays by the use of substances favorable to cathodic emissions, such as alkaline-earthy oxides, lime, etc., or ultra-violet light. The invention provides suitable oscillating circuits, also an accelerating circuit excited by a dynamo. The plates 4 and 4[1] act as the coatings of a condenser, and are connected with a transformer as indicated. In action the cathode beam is oscillated between the anodes, 5 and 5[1]. By means of the condenser 8, the sustained oscillations produced by this device can be usefully employed.

COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

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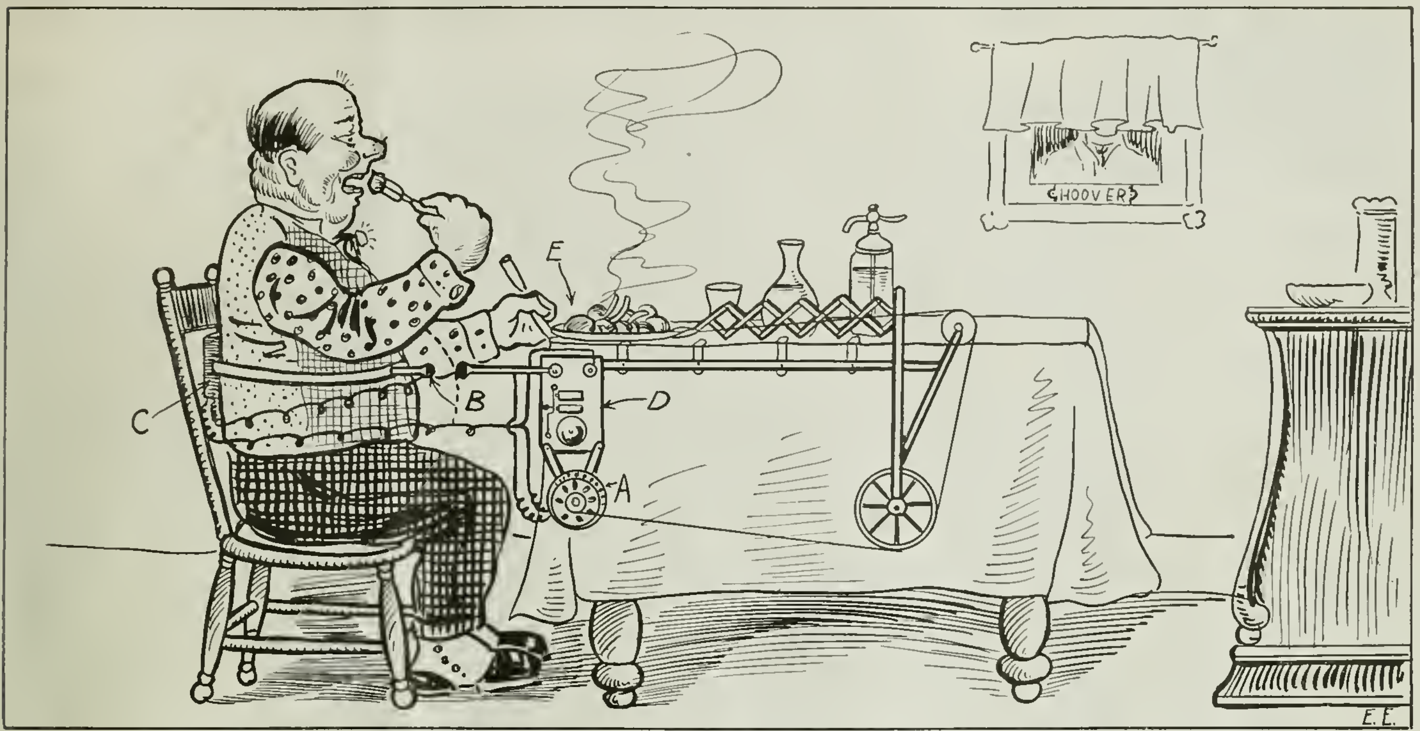
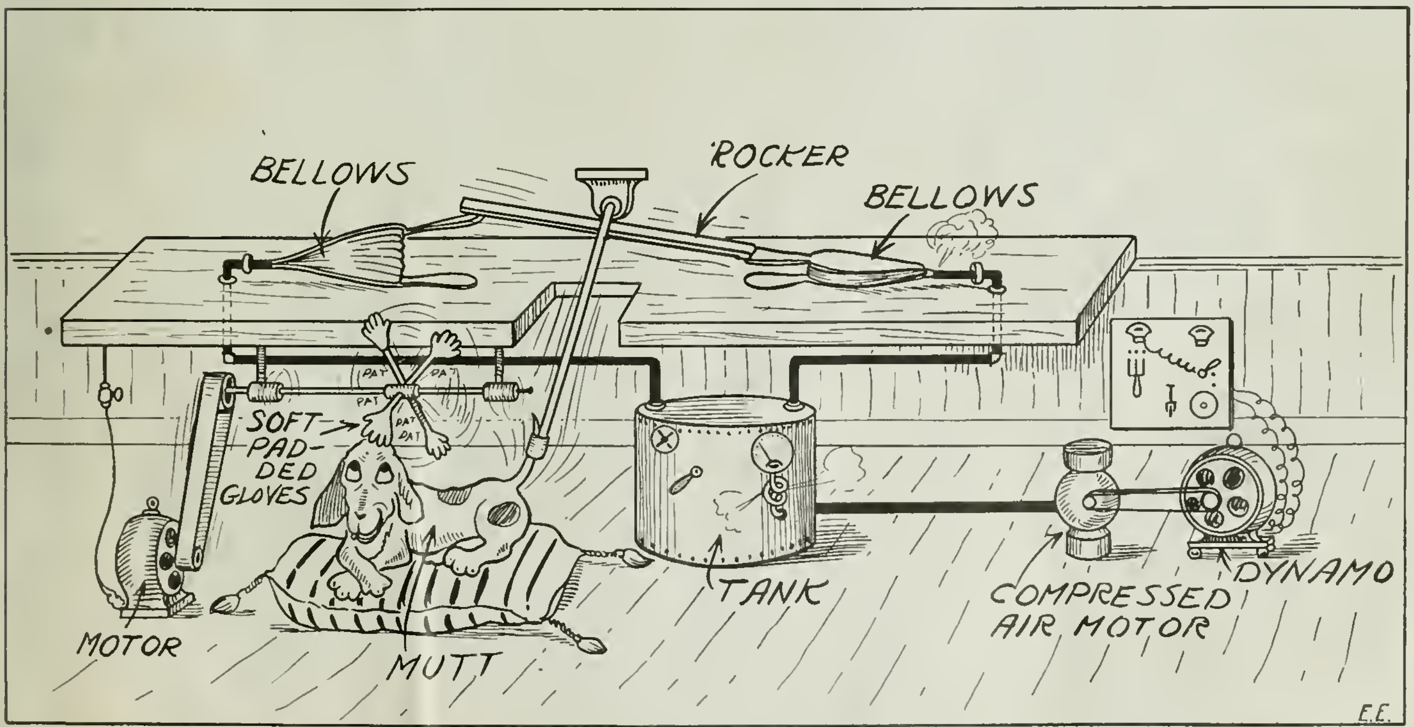


Prize Winner. ELECTRIC HOOVERIZER. At Last Mr. Hoover May Put His Mind at Rest, for with the Application of This Marvelous Automatic Electric "Hooverizer" to All Hotels and Restaurants, not to Mention Leven-steen Million Private Families Thruout the Land, the Worries of Saving Grub Will Be Over for All of Us. How does it work?—Simplest Thing in the World, My Boy. You See, It Works Thusly:—When the Diner, Properly Equipt with the "Hooverizing" Machine, eats a Certain Prearranged Quantity of War Bread, Bran Muffins and Molasses Cake, the Increase in His Girth Causes Electric Contacts B, to Close, Thus Passing Current (Not Currant) from Battery C, Into Alarm Bell D and Motor A. The Motor Winds Up a Cable as Shown, Which Causes the Expansible Arm to Yank the Plate E, Away from the Diner, When the Waiter Appears and Scrapes the Remains Into His "Hooverizing" Pail.. Inventor, George I. Jones, Emporia, Kansas.



ELECTRO MUTT-MOTOR. I Hereby Declare the Following Not to Be the Correct Explanation of My World-Startling Conception for the Production of "Perpetual Motion":—First We Need a Nice Tame Mutt-Genus Mexicano Sans Hair—His Royal Nibs Being Pleasantly Situated on the Northeast Corner of a Lamb's-Wool Cushion, All as Illustrated. Now We Start the Motor Driving the Revolving Rubber Hands; Senior de Puppo Is Much Pleased, Wags His Tail and Operates the Two Air Bellows, Thus Compressing Air Into Tank. Compress Air from Tank Drives Pneumatic Motor Connected to Dynamo; Result, "Free Electricity" as Long as the Mutt Lives. Inventor, Harry W. Haenigsen, Jr., Pompton Lakes, N. J.

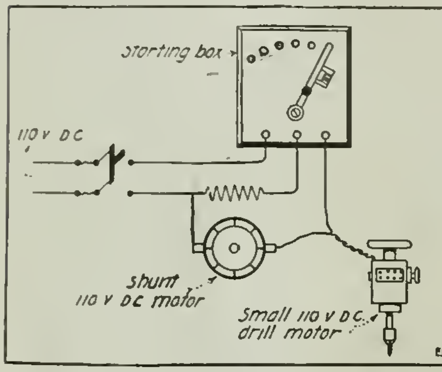
The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no pencil matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

OPERATING MOTORS IN SERIES.

(932) Robt. Kremer, Bronx, N. Y., writes:

Q. 1. Will it harm a small 110-volt D. C. motor to connect in series with a large 110-volt D. C. motor?



Special Hook-Up for Two 110 Volt D. C. Motors Connected In Series

A. 1. Relative to the matter of connecting a small 110-volt D. C. motor in series with a large 110-volt D. C. motor we can assure you that the larger machine in such a case will have no untoward or dangerous effect whatever with respect to the smaller machine. The large motor, rated in this case at 2 H. P., will not act as a "reservoir" of electrical energy with respect to the small motor, and it will make practically no difference in the operation of the little machine except that so long as it is left in series with the small motor, it will cause the speed of the latter to be below normal, owing to the fact that the electrical resistance of the 2 H. P. will cause a drop in the E. M. F., or voltage, reaching the small motor.

As you will see, this is in agreement with your statement that under these conditions the small electric drill motor does not reach normal speed even with the large motor starting-box arm placed in the last position or notch for the reason above stated,—*i. e.*, due to the drop of potential caused by the resistance of the large motor. This drop in potential is given by the formula: Drop in E. M. F. equals resistance times current flowing thru it.

HAMMOND'S RADIO CONTROL SYSTEM.

(933) W. W. G., Canton, Ohio, asks:

Q. 1. Has John Hays Hammond, Jr., succeeded in developing his radio controlled torpedoes so that they are interference proof?

A. 1. As to the success attained by Mr. John Hays Hammond, Jr., in his radio control experiments, we do not know definitely as to the exact measure of success he has found in this direction, but from all reports which we have come in contact with in the past few years, it seems that he has a fairly good selective radio control system worked out.

We do not see, however, why you would not do well to follow up this line of work, as there seems to be very good room for improvement in many ways. From our experience in radio matters, we should say that it will undoubtedly take some very excellent and thoro research work indeed to make an absolutely "interference" proof radio control scheme for operating torpedos and the like. There is plenty of opportunity for improvement in this branch of the art regardless of the work done by Mr. Hammond's staff of experts.

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As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 to 150 words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

BAROMETER QUERY.

(934) ELECTRICAL EXPERIMENTER, Bridgton, Mo., writes the Oracle:—

Q. 1. If a barometer tube is tilted at an angle, will this change the reading?

A. 1. Your particular case is that of a water barometer, and as in any barometer the vertical height is the important factor. We should say that the angle at which the pipe is tilted will have no bearing on the situation except for that of the vertical height. In other words, the length of the line from the level of the water in the tube is constant, no matter at what angle the bulb is tilted.

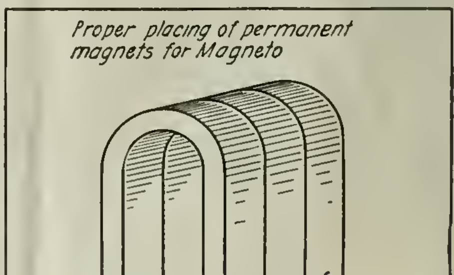
Take note of the fact that water cannot be raised to any greater height than 32 to 33 feet by atmospheric pressure.

WEAK MAGNETO.

(935) P. Wolfe, Alaska, asks several queries relative to a weak ignition magneto.

A. 1. One of the main reasons for the magneto giving a weak spark is that the steel magnets are usually improperly placed. They should be placed with their N and S poles as shown in the accompanying diagram. Furthermore, the more the number of turns of wire on the armature, the greater the E. M. F., and the thicker the wire, the greater the current. Therefore it is very important to get as many turns on as possible to get the best results for a constant amount of current.

The way by which a battery current tends to demagnetize the steel magnets of the magneto is that the current of the battery



How the Magnet Poles of Compound Magneto Fields Should Be Lined Up.

will set up a magnetic field which tends to weaken the field of the steel magnet. Another way by which the steel magnets may

(*Continued on page* 193)

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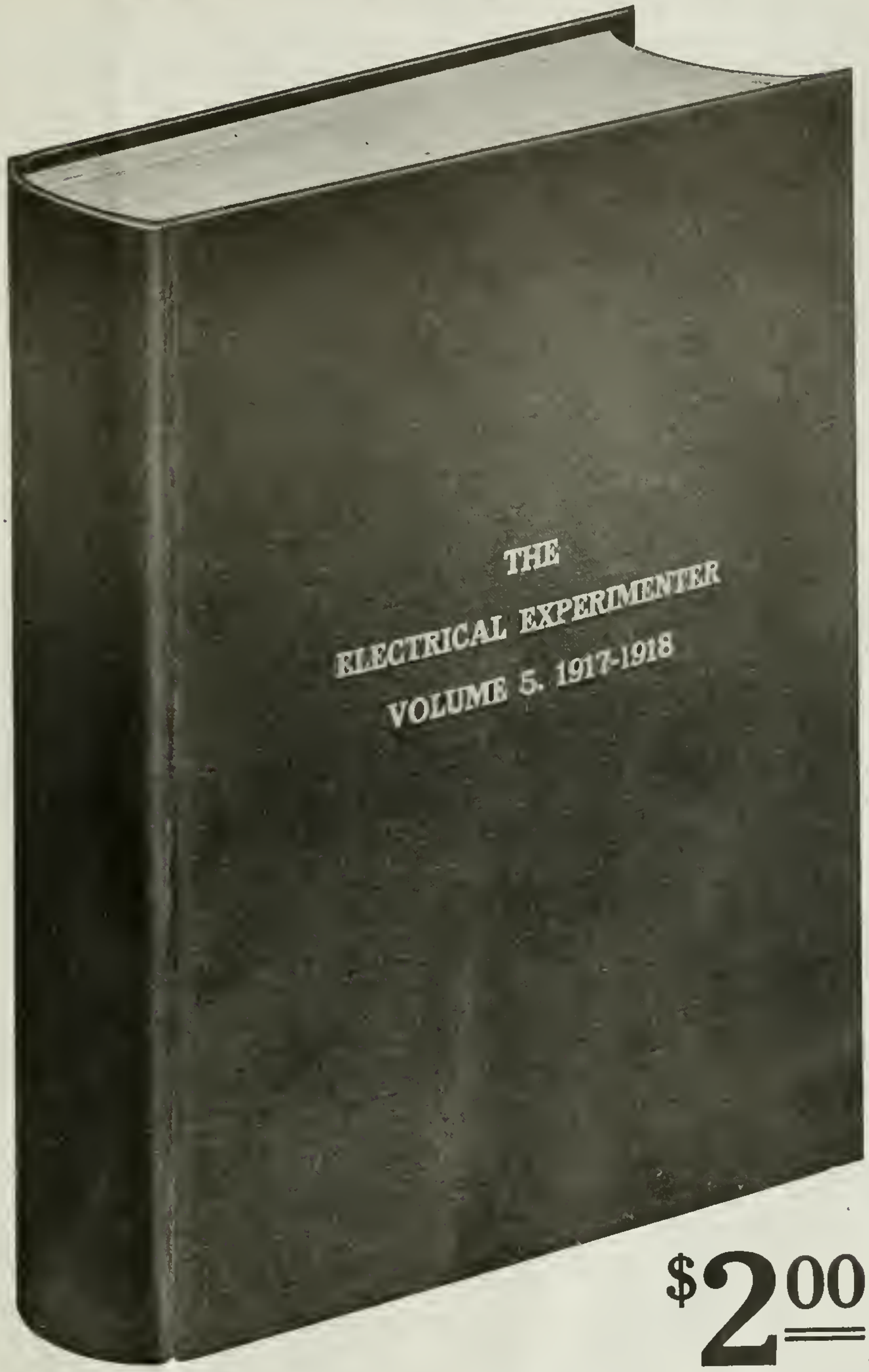

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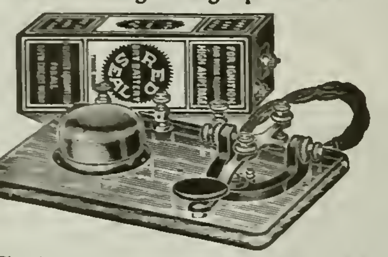

The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

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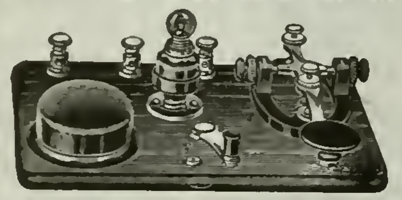

This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.

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EXPERIMENTAL CHEMISTRY.

(*Continued from page 186*)

ings of soap, not over a gram in 100 cc. of soft water, heating the latter to facilitate solution. The solution must be reasonably clear; if it is not, use more water.

Now prepare some bicarbonat of calcium solution by passing carbon dioxid from a generator into 20 cc. of calcium hydroxid solution till the precipitat at first formed is dissolved. This solution must be clear, and if necessary to make it so, should be filtered. This solution is *hard water.*

Take 10 cc. of this solution and add the same volume of soap solution, both of which should be clear before mixing. Shake them well together and note the effect. Is a lather formed? Is there a precipitat?

Take 10 cc. of distilled or other soft water and add an equal volume of the soap solution. Is a lather formed in this case or a precipitat?

Boil the other 10 cc. of bicarbonat of calcium solution till the calcium carbonat is precipitated; then filter, and to the clear filtrat add an equal volume of soap solution. Shake the mixture well and note whether a lather or an insoluble substance is formed. Has the water been softened? What is one method of softening this sort of hard water?

Make a solution of magnesium sulfate in water, 2 grams of the salt to 20 cc. of water. Add soap solution, volume for volume, shake together, and as before, note result. With the remaining 10 cc. see whether boiling has the same effect on the sulfate that it did on the bicarbonat.

Experiment No. 138.

CARBON MONOXID.

Preparation from Oxalic Acid and Sulfuric Acid.

CAUTION!!! REMEMBER THAT CARBON MONOXID GAS IS A DEADLY POISON, AND GREAT CARE SHOULD BE EXERCISED IN ITS PREPARATION, AND IN EXPERIMENTS MADE WITH IT. ONE PER CENT OF IT IN AIR WHEN INHALED HAVING PROVED FATAL, IT SHOULD NOT BE MADE EXCEPT AT A "HOOD" OR WITH GOOD VENTILATION.

Put into a plain, thin Erlenmeyer flask of about 250 cc. capacity, 10 grams of oxalic acid crystals and pour thru the thistle tube 20 cc. of concentrated sulfuric acid. The delivery tube from the two-hole rubber stopper leads into an intervening bottle, which contains a strong solution of sodium hydroxid, or potassium hydroxid, about half filling the bottle, the delivery tube reaching nearly to the bottom (see Fig. 123). From this bottle runs a delivery tube to the tray or pneumatic trough, the carbon monoxid being collected over water like oxygen. Set the flask on a triangle with asbestos and apply gentle heat. Collect three or four receivers of the gas, having one large bottle to collect any surplus, thus avoiding contamination of the air after the heat is withdrawn. When once started the chemical action will take care of itself and the heat can be withdrawn. In any event the action should not be too vigorous. Water poured thru the thistle tube will cool and hinder the action.

The oxalic acid breaks up into carbon dioxid, carbon monoxid and water. It will be noticed that oxalic acid ($H_2C_2O_4$), which is a solid, consists of H, C, and O in the exact proportion to form the carbon dioxid, carbon monoxid, and water. Heat alone will break up the acid into these constituents, but sulfuric acid aids in the operation and also absorbs the water, leaving the two gases carbon dioxid and carbon monoxid completely intermingled. Thus the function of the sulfuric acid in this experiment is only to absorb the water, for which it has great affinity. Remembering the affinity which carbon dioxid has for soluble hydroxides, the use of the sodium hydroxid in this experiment is to absorb the carbon dioxid, thus permitting the carbon monoxid, which is insoluble in water, to be collected in a similar manner to hydrogen. The equation of the complete reaction is:

$$H_2C_2O_4 = CO_2 + CO + H_2O$$

$$CO_2 + CO + 2NaOH = Na_2CO_3 + H_2O + CO$$

Test the gas collected, after taking out the bottles one at a time, by using a lighted splint, removing the cover glass at the time. Test with limewater the product of combustion, some of which is left in the receiver.

What color did the flame have? Is the gas a supporter? Is it a combustible?

On detaching the apparatus burn the gas in the generator and all bottles, carefully avoiding inhaling any.

(*To be continued.*)

WILL THE GERMANS BOMBARD NEW YORK?

(*Continued from page 157*)

tral switchboard as shown in our illustration. The idea of course is to listen in for the whirr of submarine propellers. The Navy Department has a pretty good idea what ships are leaving New York at any time, and in what position these ships should be at any given time. If every outgoing and incoming ship were to take a certain prescribed route, then the work of the listening-in operator would be vastly simplified.

The Navy Department also knows the exact whereabouts of its own submarines, and the propeller sounds of our own ships as well as the sounds of our own submarines, can therefore be eliminated. Then if the operator hears a certain propeller or motor sound which is not located along the regular prescribed routes, he will immediately be informed that the enemy is about and destroyers can be despatched post-haste towards the direction of the buoy from whence the suspicious sounds came.

By means of a subaqueous defense of this kind, it would become an easy matter for the Navy Department to practically make it impossible for the German submarines to break thru the defense unnoticed. In that case it would of course be impossible for the German submarines to assemble their aeroplanes and the attempted raid would be frustrated before it got well under way. A defense of this kind would not be so very costly, and it is certainly practical. Microphone buoys of this kind are usually located from thirty-five feet to fifty feet below the surface, as then the wave motion on top of the ocean will not interfere with the microphones, as at this depth no sound from above reaches them.

On the other hand, these buoys being only small affairs, and being submerged so deeply are quite unseen and unnoticed by the enemy who does not know their whereabouts, this being known only to the Navy Department.

The writer is confident that a device of this kind would help us towards the elimination of the aerial menace, which only fools deny exists.

THE ORACLE

(*Continued from page* 190)

be demagnetized is that of mechanical shock, and this should be avoided as much as possible.

BOOK ON DESIGN OF ELECTRO-MAGNETS.

(936) J. Morton, Wilmington, Del., asks:

Q. 1. What good book can you recommend on the design of electro-magnets?

A. 1. We can furnish a very good book on the design of electro-magnets and solenoids at $2.15 prepaid, entitled "Solenoids and Electro-Magnetic Windings," by Underhill.

MEANING OF D. S. C. AND S. S. C.

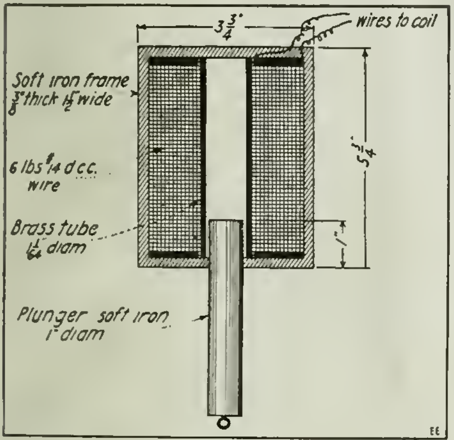
(937) Harold Wengatz, Box 165, Rose, N. Y., inquires:

Q. 1. What is the exact meaning of magnet wire designations, such as D. S. C. and S. S. C.?

A. 1. With reference to the terms "D. S. C." and "S. S. C." would say that D.S.C. stands for *double silk covered* magnet wire, while S.S.C. stands for *single silk covered* magnet wire. In the trade the term "C" is usually dropt now-a-days, the wire being termed simply "D.S." wire, etc.

SOLENOID DATA.

(938) N. W. Petefish, La Cygne, Kansas, wishes data on building a small solenoid.



Typical Design of Solenoid Or Suction Type of Electro-Magnet.

A. 1. We give details herewith necessary for the construction of an electro-magnet capable of lifting 8 lbs., thru a distance of 4".

Wind about 6 lbs. of No. 14 D. C. C. wire on the spool shown in the accompanying diagram, and then enclose this winding with very soft iron, of the dimensions shown. It is to be noted that the plunger will always be in its socket about 1" deep, the reason for this being that a larger pull is given at the start, than were the plunger to be merely at the end of the coil.

LAMP BANK AND ELECTROLYTIC INTERRUPTER.

(939) Clifton A. Sibley, Salem, Mass., asks:

Q. 1. Can I not use a lamp bank instead of an electrolytic interrupter on a 110-volt circuit with a spark coil?

A. 1. Your assumption in using a bank of lamps in place of an electrolytic interrupter is entirely wrong. The function of the interrupter is to interrupt the current many hundred times per second, and it accomplishes this by having a bubble of gas form at one of the electrodes which constantly breaks, and as you can see when this happens a circuit is made.

The reason why lamps are put in a circuit is solely to control the amount of current flowing thru the circuit.

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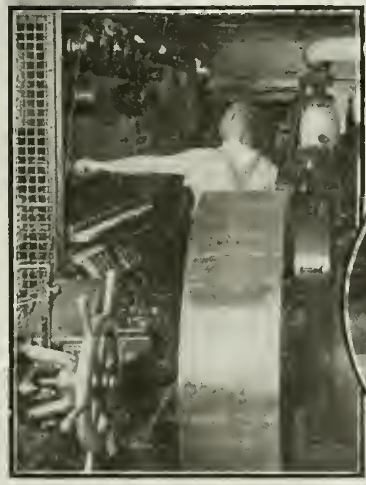

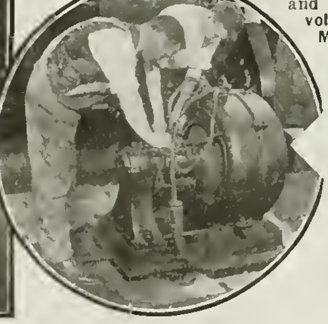

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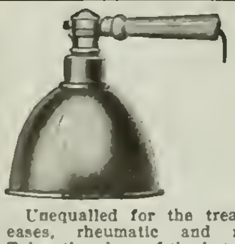

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EXPERIMENTAL PHYSICS.

(*Continued from page* 171)

to bring the leaves to their original divergence, *i.e.*, we have greater capacity to store up electricity now. These two plates (one being grounded) separated by an insulator (air) form what is known as a *condenser*.

Figure 71-b shows a popular form of condenser, the *Leyden jar*. Instead of two plates with air between them as insulators, we have here two sheets of tin foil, one inside and the other outside a jar, the glass of which forms the intervening insulator. Inside tin foil coating a conductor leads to metal knob. If after charging the Leyden jar we connect the outer and inner coats by a discharger (a conductor with an insulated handle) a powerful spark will jump as in Fig. 71-c.

EXPERIMENT 79—Place a pie tin (D) on a sheet of glass (E) to insulate it, (Fig. 72-a). Pour enough molten sealing wax (C) to fill the pie tin at least ¼-inch deep and allow it to harden. Next place another but smaller pie tin (B) on the sealing wax, being careful not to allow it to touch pie tin (D). Attach a piece of hard rubber or sealing wax (A) to pie tin (B). This simple apparatus makes up the *electrophorus*, the simplest static electrical machine. Its operation is as follows: Raise pie tin (B) by insulated handle (A). Rub sealing wax (C) with flannel or better with cat's fur. Now replace (B); since the sealing wax has been charged it draws the opposite charge of the neutral (B) near it and repels the same charge from it as in Fig. 72-b. Now touch (B) with the finger. This allows the negative to pass thru your body while the positive is held by the charge on (C). Remove finger and now raise (B). It is obvious from Fig. 72-b that (B) is now *positively* charged, and if we bring it near a conductor or the cat's nose a spark will jump from (B).

The *Wimshurst machine* is a contrivance which goes thru the same operations as we have done with the electrophorus, except that it stores the electricity in Leyden jars, which form a part of the machine. When the charge is large a powerful spark is gotten. Performing the operations rapidly we are able to secure sparks in rapid succession. The writer regrets that lack of space prevents giving a detailed explanation, but should any reader be interested he is referred to any standard High School Physics book. (Should any or all of these experiments fail to give the correct results, do not be discouraged but try again. Atmospheric conditions have a great deal to do with the results and even with the best of apparatus on damp days the experiments frequently fail.)

(*To be continued.*)

MILESTONES IN THE LIFE OF THOMAS A. EDISON.

(*Continued from page* 161)

great plant at West Orange, N. J., was the scene of a great conflagration. Early next morning gangs of men were at work clearing up the wreck. Hundreds more were added during the day and work was continued 24 hours a day. Within 36 hours after the fire Edison had given full orders for the complete rehabilitation of the plant.

1915.

Early in the year 1915 Edison found that he was in danger of being unable to obtain a continuous supply of benzol, from which he made his synthetic carbolic acid. He decided to erect his own benzol plants. He experimented and perfected it in his laboratory at Orange, N. J., and arranged with two coke oven plants to put in his benzol plants. The first was installed at the Cambria Steel Company's plant at Johnstown, Pa., which was installed and put into operation in 45 days. Four other plants have since been installed.

The same year Edison conceived the idea of helping the textile and rubber industries of America by making myrbane, aniline oil and aniline salt, which had previously been imported from Germany. With much effort and hard work, he installed a plant in 45 days, commencing deliveries in June, 1915. He is now manufacturing 4,000 pounds a day.

1917—

Since the United States entered the war, Mr. Edison has been constantly co-operating with the United States Government in various experiments, making them at Orange, N. J., and elsewhere.

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(*b*) The education called for under (*a*) and one year as a paid wireless operator, and one year in special radio work, such as the manufacture, installation, or adjustment of commercial or governmental wireless apparatus.

(*c*) At least a senior student in a college or university of recognized standing, having pursued for three years a scientific course of study including radio and kindred sciences, such senior students being admitted to the examination subject to their furnishing proof of actual graduation within three months from the date of making oath to the application.

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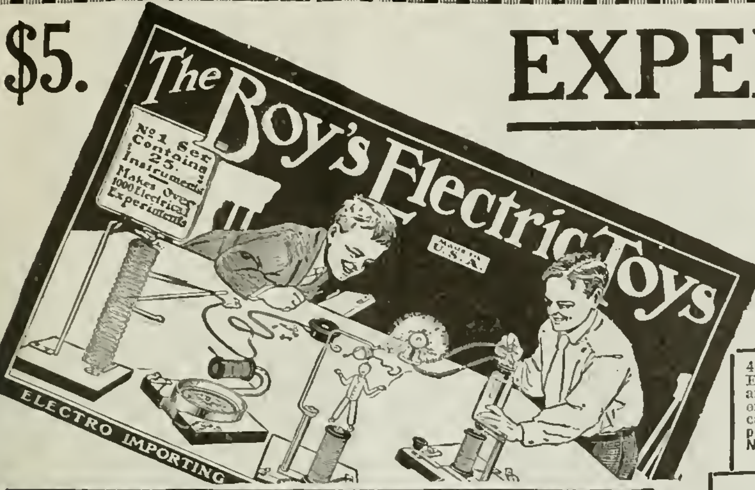

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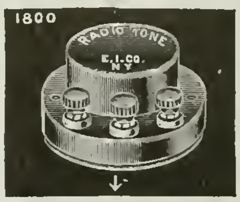

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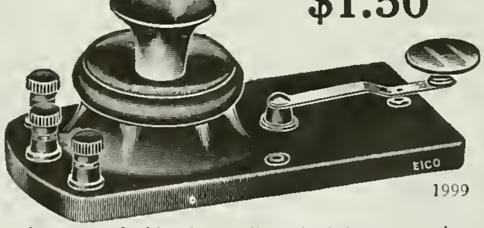

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COLONEL CARTY RECEIVES EDISON MEDAL.

(*Continued from page* 173)

the U. S. Army. If General Pershing has his way, Carty will be a General before many a day. General Pershing understands that Carty is made of stuff of which great generals are made."

John Joseph Carty was born at Cambridge, Mass., on April 14, 1861. Nature endowed him with a clear, keen mind, a liking for mechanical experimentation and an infinite capacity for work. He was graduated from the Cambridge Latin School and intended to enter Harvard University, but was prevented by a serious trouble with his eyes, which made it impossible for him to prepare for the college entrance examinations.

He became interested in the telephone, then a new scientific device unappreciated by the majority of persons, and in 1879 started work in the Bell System with the Telephone Dispatch Company of Boston. In 1887 he took charge of the Western Electric Eastern Cable Department, and later of the Western Electric Eastern Switchboard Department. In 1889 he became Chief Engineer of the New York Telephone Company, then the Metropolitan Telephone and Telegraph Company, and while in this position, twice directed the technical work in connection with the reconstruction of this company's plant, once when the system was changed from ground circuit to metallic circuit, and the second time when it was changed from local battery to common battery.

Colonel Carty's honors are almost as numerous as his contributions to the science of telephony. He received the degree of Doctor of Engineering, from Stevens Institute of Technology, in 1915; Doctor of Science from the University of Chicago and from Bowdoin College in 1916; Doctor of Laws from McGill University in 1917. In 1903 he received the Edward Longstreth Medal from the Franklin Institute of Pennsylvania, and in 1916 the Franklin Institute bestowed upon him its highest honor, the Franklin Medal, "in recognition of his distinguisht service to mankind rendered in the field of Science."

For his service in connection with the establishment and development of the telephone system in Japan, Colonel Carty twice received the formal thanks of the Japanese Imperial Government, was decorated by the Emperor of Japan in 1909 with the Imperial Order of the Rising Sun, and in 1912 with the Imperial Order of the Sacred Treasure of the Meiji.

Colonel Carty is a past president of the American Institute of Electrical Engineers, of which he has been a member since 1890, and a fellow since 1913. He is Chairman of the Executive Committee of the National Research Council, a trustee of the Carnegie Institution of Washington, a past president and life member of the New York Electrical Society, a fellow of the American Academy of Arts and Sciences, a fellow of the New York Academy of Sciences, and an honorary fellow of the American Electro-Therapeutic Association. He is a member of the Society for the Promotion of Engineering Education, the National Society for the Promotion of Industrial Education, the American Physical Society, the Franklin Institute of Philadelphia, the American Association for the Advancement of Science, the Society of Arts of the Massachusetts Institute of Technology, the Telephone Pioneers of America, the Association of Railways and Telegraph Superintendents, the American Geographic Society, and various telephone societies.

FULMINATES.

(*Continued from page* 185)

active substances, since it would tend to increase the temperature of the flash by burning the carbonic oxid into carbon dioxid, and would insure the ignition of the cartridge. For military caps, in this country, potassium chlorat is always mixed with the fulminate, and *powdered glass* is sometimes added to increase the sensibility of the mixture to explosion by percussion. *Antimony sulfid* is sometimes substituted for powdered glass, apparently for the purpose of lengthening the flash by taking advantage of the powerful oxidizing action of potassium chlorat upon that compound. Since the composition is very liable to explode under friction, it is made in small quantities at a time, and without contact with any hard substance. After a little of the composition has been introduced into the cap, it is made to adhere and waterproofed by a drop of solution of shellac in wine.

If a thin train of *mercuric fulminate* be laid upon a plate, and covered, except a little at one end, with *gunpowder,* it will be found on touching the fulminate with a hot wire, that its explosion scatters the gunpowder, but does not inflame it. On repeating the experiment with a mixture of 10 grains of fulminate and 15 grains of *potassium chlorate* (mixed upon paper with a card), the explosion will be found to inflame the gunpowder. (See Fig. 1.)

By sprinkling a thin layer of the fulminate upon a glass plate, and firing it with a hot wire, the separated mercury may be made to coat the glass, so as to give it all the appearance of a looking-glass. (See Fig. 2.)

Altho the effect produced by the explosion of mercuric fulminate is very violent in its immediate neighborhood, it is slightly felt at a distance, and the sudden expansion of the gas will burst fire-arms, because it does not allow time for overcoming the inertia of the ball, tho, if the barrel escape destruction, the projectile effect of the fulminate is found inferior to that of powder. It has been proved by experiment that the mean pressure exerted by the explosion of mercuric fulminate is very much lower than that produced by gun-cotton, and only three-fourths of that produced by nitroglycerin. Its great pressure is due to its instantaneous decomposition into CO, N, and Hg vapor within a space not sensibly greater than the volume of the fulminate itself, which volume being very small, on account of the high density of the fulminate, the escaping gases exert an enormous pressure at the moment of explosion.

This detonating property of mercuric fulminate renders it exceedingly useful for effecting the detonation of gun-cotton and nitroglycerin. Berthellot finds that even such stable gases as acetylene, cyanogen and nitrid oxid are decomposed into their elements by the detonation of mercuric fulminate. Mercuric fulminate is generally contaminated with mercuric oxalat, which is one of the secondary products formed during its preparation.

Fulminate of silver.—*Silver fulminate* is prepared by a process very similar to that for fulminate of mercury; but since its *explosive properties are far more violent,* it is not advisable to prepare so large a quantity. 10 grains of silver are dissolved at a gentle heat, in 70 minims of ordinary concentrated nitric acid (sp. gr. 1.42) and 50 minims of water. As soon as the silver is dissolved, the lamp is removed, and 200 minims of alcohol (sp. gr. 0.87) are added. If the action does not commence after a short time, a very gentle heat may be applied until effervescence begins, when the fulminate of silver will be deposited in minute needles and may be further treated

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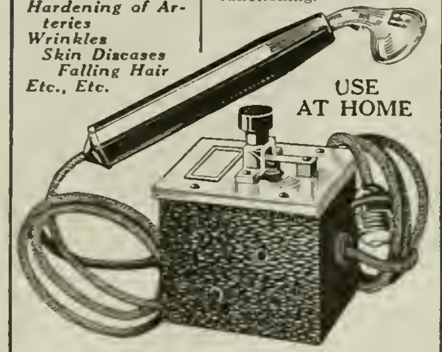

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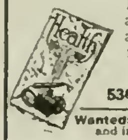

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as in the case of fulminate of mercury. (NOTE:—If the nitric acid and alcohol are not of the exact strength here prescribed, it may be somewhat difficult to start the action unless two or three drops of red nitric acid [containing nitrous acid] are added. Standard silver [containing copper] may be used for preparing the fulminate.) Silver fulminate is also prepared when nitrous anhydrid is past into an alcoholic solution of silver nitrat. When dry, the fulminate must be handled with the greatest caution, since it is exploded far more easily than the mercury salt; it should be kept in small quantities, wrapt up separately in paper, and placed in a cardboard box. Nothing harder than paper should be employed in manipulating it. The violence of its explosion renders it useless for percussion caps, but it is employed in *detonating crackers*. Silver fulminate is sparingly soluble in cold water, but dissolves in 36 parts of boiling water.

If a minute particle of the fulminate be placed upon a piece of quartz, and gently prest with the angle of another piece, it will explode with a flash and smart report.

A *throw-down detonating cracker* (Fig. 3) may be made by rolling up a particle of silver fulminate in a piece of thin paper, with some fragments obtained by crushing a common quartz pebble.

The explosion of *silver fulminate* may be compared with that of the *mercury salt*, by heating small equal quantities upon thin copper or platinum foil, when the fulminate of mercury will explode with a slight puff, and will not injure the foil, but that of silver will give a loud crack and rend a hole in the metal. (See Fig. 4.)

If a particle of silver fulminate be placed upon a glass plate and touched with a glass rod dipt in oil of vitriol, it will detonate and leave a deposit of silver upon the glass.

When silver fulminate is dissolved in warm ammonia, the solution deposits, on cooling, crystals of a double fulminate of silver and ammonium, which is even more violently explosive, and is dangerous while still moist. A similar compound is formed with mercuric fulminate.

Silver fulminate is also formed when freshly precipitated silver oxide is covered with a strong solution of ammonia, and allowed to stand for some hours, when it becomes black, and acquires dangerously explosive properties.

Fulminating platinum.—This is obtained by dissolving platinic oxid in diluted sulfuric acid, and mixing the solution with an excess of ammonia, when a black precipitat of fulminating platinum is obtained, which detonates violently at about 400 degrees F.

Fulminating gold.—This is obtained as a buff precipitat when ammonia is added to a solution of auric chlorid; its composition is not well establisht. It explodes violently when gently heated.

Fulminate of copper.—This is obtained by digesting copper (in the form of powder or filings) with fulminate of mercury or silver and a little water. It forms soluble green crystals which explode with a green flame. There are many other fulminates and they are all explosive.

THE STORY OF A POUND OF COAL.

(*Continued from page* 158)

power. Thus of the electrical energy put into the lamps we only receive five per cent in the form of radiant light,—the other 95 per cent is lost. Lost, all because we of to-day do not know enough to more efficiently convert electric current into radiant light. At the present energy consumption of 1 watt per C. P. for a tungsten lamp and figuring on the perfect tranformation of the energy in *one pound* of coal, *viz.*, 14,150 B. T. U. we would get (14.15 x .293 kilo-watt-hour = 4.14 K.W. hr.) 4,145 candle-power, as represented by the large lamp at the right of the illustration. As a matter of fact we only manage to get 1.45 x .293 K.W.

Analysis of Average Losses in Conversion of One Pound of Coal Into Electricity.

No.	Part of Plant.	B. T. U.	Per cent.	B. T. U.	Per cent.
1.	B. T. U. per lb. coal supplied	14,150	100.00		
2.	Loss in ashes			340	2.4
3.	Loss to stack			3,212	22.7
4.	Loss in boiler radiation and leakage			1,131	8.0
5.	Returned by feed-water heater	441	3.1		
6.	Returned by economizer	960	6.8		
7.	Loss in pipe radiation			28	0.2
8.	Delivered to circulator			223	1.6
9.	Delivered to feed-pump			203	1.4
10.	Loss in leakage and high pressure drips			152	1.1
11.	Delivered to small auxiliaries			51	0.4
12.	Heating			31	0.2
13.	Loss in engine friction			111	0.8
14.	Electrical losses			36	0.3
15.	Engine radiation losses			28	0.2
16.	Rejected to condenser			8,524	60.1
17.	To house auxiliaries			29	0.2
		15,551	109.9	14,099	99.6 total loss
		14,099	99.6		
	Delivered to bus-bar	1,452	10.3 gross efficiency		

hr. or .424 kilowatt-hour, owing to the nearly 90 per cent loss in the steam-electric generating system. This results in 424 candle-power, as represented by the small tungsten lamp at the left of the illustration, based on 1 watt per candle-power.

The *over-all efficiency* of the entire system, from coal burned to radiant light is thus seen to be 10.3 per cent multiplied by 5 per cent or .51 of 1 per cent; or a little over one-half of 1 per cent! Think of it! All we get out of the coal, no matter how much we burn, is a paltry *one-half of one per cent*. One immediate remedy for this wasteful system of utilizing coal as a source of energy is the mouth-of-mine plant. These electric generating stations, placed at the mines, eliminate all carting and hauling of coal and permit the high tension electric current produced to be transmitted hundreds of miles at very high efficiency.

POPULAR ASTRONOMY.

(*Continued from page* 169)

the other and shuts off a portion of its light. For this reason the light of these stars is variable and passes thru periods of maximum and minimum brightness in a few days, sometimes in a few hours. They are what are called short period variable stars and, conversely, practically all short period variable stars have been found to be close double star systems. The most illustrious eclipsing binary star is the star *Beta Persei* or *Algol*. As it is a typical member of this class of stars, we will outline briefly what the nature of the light curve of the bright star and the shifting of the lines in its spectrum tell us of the system.

Fig. 1 shows the form of the light curve of Algol. In an unvarying period of $2^d\ 20^h\ 48^m\ 55^s$ the light of this star goes thru a *cycle* of change. During most of this time its light is nearly constant, but suddenly within 4½ hours it rapidly declines until it has lost 64% of its original brightness. It remains at this minimum brightness (A_1 in Fig. 1) for about twenty minutes and then rapidly rises to its original value in 3½ hours. For a long time it was impossible to detect the secondary minimum (A_3 in Fig. 1), but finally by attaching a selenium cell to the telescope, which device is particularly susceptible to light changes, the position of the secondary minimum midway between the principle minima was located. An examination of Fig. 3 will explain the nature of the light changes of Algol.

A_1, A_2, A_3 and A_4 are positions of the bright star in its orbit and a_1, a_2, a_3 and a_4 corresponding positions of the dark star. The two stars are always in line with C, the center of gravity of the system. When the faint star is in the position a_1 it shuts off 64% of the light of A_1 by *partially* eclipsing it (the two orbits are not in the same plane). When at a_3 the faint star is itself eclipsed by A in the position A_3. The extremely small amount of the decrease in light from the systems when the stars are in this position (see Fig. 1, A_3) shows how feeble is the light of a. The amount of light shut off when a is eclipsed is inappreciable to the eye directly and is only recorded by the sensitive selenium cell. It was formerly believed that the star was totally dark. In the positions A_2, a_2 and A_4, a_4 the light from the system is a maximum, as it comes freely from both stars.

Fig. 2 shows the shift of four dark lines in the spectrum of Algol (the dark absorption lines of hydrogen). The star a is too faint to give a visible spectrum and but one set of lines is seen. The normal spectrum of A is at the top (Fig. 2) and corresponds to the position A_1. The position of the lines in A_3 is also normal. In these two positions the radial velocity—that is, velocity in the line of sight—towards or away from the earth is zero. The motion of a star in its orbit is at right angles to the path at any one point, so at A_1 A_3 the bright star is moving across the line of sight or direction to the earth which is assumed to be toward the bottom of the page. At A_4 (see Fig. 3 and Fig. 2) the star is moving at greatest speed toward the earth and the lines in the spectrum have their greatest displacement toward the violet end of the spectrum. At A_2 the star is receding at greatest speed from the earth and the displacement is greatest toward the red. The amount of these displacements measures the velocity of Algol in its orbit, after the radial velocity of the system as a whole thru space is allowed for. The total period of the shift in the lines and the period of light variations are the same, showing conclusively that Fig. 3 represents the true conditions that exist in this system.

From the duration and amount of the variation of light and the spectroscopic evidence the following facts are known respecting this system: *The two stars are nearly equal in size, the dark companion being slightly larger. The distance between the centers of the stars is about* 4.8 *times the radius of the bright star. The surface brightness of the faint star is only* .05 *of the surface brightness of the principal star and its density is slightly less. The density of Algol, the light star, is only* .18 *of the density of our own sun and its diameter is a little OVER ONE MILLION MILES. Its velocity in its orbit determined by the displacement of the lines is* 28 *miles per second and the orbital velocity of its companion must be about* 60 *miles per second.*

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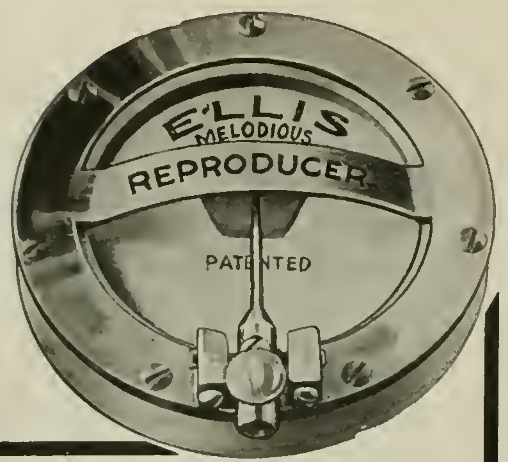

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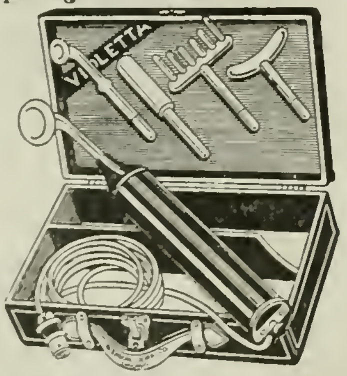

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RADIUM EMANATION IN THE TREATMENT OF DISEASE.

(*Continued from page* 167)

The importance of estimating phenomena quantitatively, and of making exact dosages is of great importance in the application of the radio-active substances in the treatment of cancer.

Fig. 4 represents the apparatus (diagrammatically) used for accurately measuring the quantity of the radio-active substance in the applicator or tissue. AA is a sheet of lead 50 cm. in diameter and 1.5 cm. thick. It rests on the top of a circular brass box. BB, the same diameter as AA and about 3 cm., deep. A horizontal brass disk, CC, lies in the center of this box and is insulated from it by hard rubber supports, DE. The box B is charged by joining it to one pole of a battery having an electromotive-force of 100 volts or so, and in order to prevent the current from passing from the box B to the disc C, thru or along the surface of the supports DE, the supports are supplied with metal discs and rods joined to earth as represented. Thus any current starting from the box B, along the surface of D, would meet this conductor and pass off to earth without reaching CC.

In order to measure the quantity of a radio-active substance in an applicator, the applicator is placed on top of the lead disc AA. The penetrating rays pass thru the disc into the box and ionize the air. When the air is ionized, the current passes across from the box B to the disc C. The greater the amount of the active substance on top of the lead AA, the greater will be the amount of radiation passing thru the air in the box, and the greater will be the current flowing from the box to C.

In order to measure the current flowing from the box to C, one of the supports E, is perforated, and a wire F, passes thru it and is connected to an instrument for measuring currents of electricity; usually a variable electrical condenser and a quadrant electrometer. The author has had access to a description of the above apparatus as designed by Prof. Duane.

Fig. 5 shows the apparatus used in making these measurements. The instruments are all of the highest sensitivity and are located in an isolated room some distance from the room where the apparatus for making the capillary tubes is set up.

Fig. 2 shows comparatively the size of the silver tubes used in various treatments of cancerous growths. The tube has a small threaded cap so that the glass capillary tube containing the emanation gas may be placed therein—other tubes are used of silver or platinum with a hole directly thru them. In this case both ends are sealed with a drop of wax after the emanation tube has been inserted. Screens employed for various rays are of aluminum, silver, lead and platinum.

The *alpha ray* is particularly weak. The particles lose their velocity, and therefore their activity, in a few centimeters of air, and will be completely absorbed by a very thin screen of aluminum (about 0.01 mm.). As the layer of varnish in most applicators is more dense than this amount of aluminum, it follows that the alpha rays are completely stopt by it, but the coats of varnish gradually become permeable, due partly to minute cracks, which spread thruout the layers, and partly to the absorption of emanation by the varnish, so that in course of time an applicator emits alpha rays. The varnished applicators are only used when the Radium salts are applied direct.

The *beta rays*, far more penetrating than the alpha rays, consist of negatively charged bodies projected with velocities of the same order as the velocity of light. Their velocities vary considerably, and are distinguished by the terms "soft beta" and "hard beta."

A considerable variety of screens is used according to the nature of the radiation required. The *gamma rays* are extremely penetrating and are somewhat analogous to the very penetrating Roentgen rays. In all instances the effects, and penetration depends on all three factors;—the amount of Radium used, the filteration and the distance at which the applicator is set from the tumor and the depth of the tumor, or other growth.

Secondary Rays. The use of thick screens of heavy metal is accompanied by the production of *secondary rays*, capable of causing considerable surface irritation. They may be absorbed by the use of many layers of black paper or thick rubber tubing.

Duration of Applications (Exposures). Very short exposures of 1 to 10 minutes are given for treatment of superficial skin troubles. The applicator is applied without any screen beyond that afforded by a thin rubber sheeting. *Short exposures* of 15 minutes to one hour are frequently resorted to when treating warts, ulcers, etc. The screening of these exposures rarely exceeds 0.02 mm., of aluminum. Moderately long exposures of 1 to 12 hours, are adopted when it is desired to obtain the destructive action of the rays, used in cases of rodent ulcer, rapidly growing epithelioms lupus vulgaris, etc. Exposures of 3 hours duration and upwards are usually spaced over a period of two or three days, and no screening or a screening of 0.1 mm., lead is employed.

Prolonged exposures of twenty to one hundred hours are used in the treatment of deep-seated malignant growths; lead screens are always employed, usually of 2 mm. thickness. Exposures are given in periods of six to twelve hours with an interval of at least twelve hours between successive exposures.

The Reaction. All tissues when treated with Radium respond in some manner, but the nature and extent of this response varies greatly, depending upon the particular apparatus, screening and dosage employed, the nature of the tissue treated and the conditions of the tissues treated.

Factors in treatment to be considered are age, sex, temperament and susceptibility to actinic rays. The reaction usually appears between the *seventh and fifteenth days*, and four degrees may be clearly distinguished; simple erythema, Erythema followed by desquamation, Vesication with superficial ulceration and deep ulceration, sometimes accompanied by the production of an eschar.

All kinds of opinions may be drawn from the reports of cancer experts and various statements appearing from time to time in newspapers, but preference should be extended to those who have had most exerience in handling and applying Radium. One thing is certain and that is that a larger amount of recoveries and cures have been noticed with *larger* quantity applications of Radium, and at *present* the majority of hospitals have only very *small* amounts of the element. By this I do not mean that Radium in smaller quantities is not capable of doing a great amount of good but until we acquire experience and make a larger, broader and more universal practise of it's use, thereby acquiring more and more experience, we cannot hope to receive all the benefits that undoubtedly lie apparently just behind a thin veil of mystery. Therefore, at present, the greatest good is accomplisht in general it seems, where the quantity of Radium applied is thoroly powerful enough to affect the growth or ailment being treated.

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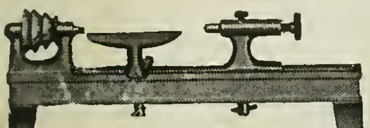

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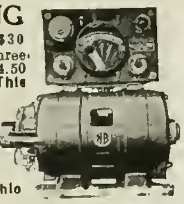

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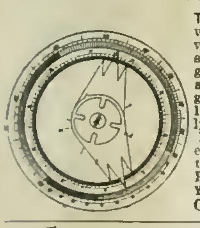

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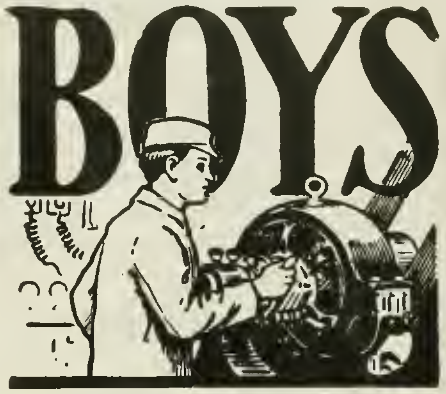

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A NEW ELECTRIC RECORDING COMPASS.

(Continued from page 165)

to realize the benefits which they could obtain from its installation aboard their vessels, but on the part of the officers of the ships. Their arguments against the inventions were not direct; they merely rested on the statement that they did not desire what they termed a "mechanical spy" on board.

A record made by the instrument during this period, while on a cruise up Long Island Sound, is given herewith.

The recording compass, as its name implies, is a device which will make a *continuous record* on a sheet of paper of whatever *courses* the ship may have taken during a cruise of any duration.

By the addition of other quite simple attachments, the *speed of the vessel* during any interval is shown as well as the *number of revolutions of the engines* and also whatever *signals* affecting the movement of the ship which may have been given. All this data is plotted automatically on a chart against time.

In the event of any controversy arising as regards the movements of the ship these records would serve to establish the justice or injustice of unkindly criticism. They would be invaluable for purposes of determining the relation of the speed to the revolutions since they show precisely what progress the vessel made at all points. In cases when "dead reckoning" must be resorted to, a record of the behavior of the ship since she left harbor would eliminate all risk from error and place this process upon a scientific basis. In legal actions based on the movements of ships, as in collision during fogs, etc.; the records would serve to show whether due caution had been exercised and hence would fix the responsibility. The operating office would have on hand a precise record showing whether their orders as regards the maneuvering of their ships had been executed; whether the pilots were properly performing their duty, etc. The value of the instrument for exploration purposes is readily apparent.

The invention consists of a spark coil capable of producing a disruptive discharge thru one inch and of the usual ship binnacle excepting that the needle is attached to a very light aluminum spiral, see photo herewith; below the *compass controlled* aluminum spiral a paper chart is fastened to a circular frame. This frame is slowly revolved by means of a step by step electrical mechanism which is visible in the illustration. The gearing being actuated periodically by an electric master clock, a slow circular motion is imparted to the chart equivalent to 5 degrees (one small angular division) per hour. The chart frame has a radial conductor to which one secondary terminal of the spark coil is attached, the other terminal is connected to the aluminum spiral thru the center support. A stream of sparks passing from the radial conductor to the aluminum spiral will perforate the paper record which is interposed between them. The aluminum spiral is held in a constant direction by the directional force exerted by the needle, while the chart changes its angular position with respect to the needle as the ship changes its course. This change in angular position produces a change of the point of intersection of the radial conductor and spiral. *Perforating the paper by an electric spark,* which will jump thru it at this intersection point, results in a record of the behavior of the ship as regards direction.

The spiral is arbitrarily selected so that at the north end of the compass it is three inches from the center, at the west point the radius vector is two and one-half inches, at south two inches and at east one and one-half inches. The spiral recedes uniformly from the center at all points, hence it is the Spiral of Archimedes. From the equation of the curve $r = a\theta$, derived from the principles of analytic geometry, a very accurate construction of the spiral is possible.

The chart is provided with three circles spaced one-quarter of an inch apart in which are recorded the speed of the vessel, the number of revolutions of the engines and whatever signals which may have been given. These records are made in the same manner, that is by *electrical perforation.* Connection to a standard taffrail log, which may be so arranged that an electrical circuit is completed every knot or multiple thereof, affords the means of recording the speed. The number of perforations in the hour division gives a measure of the speed in knots per hour. In the same way the number of revolutions of the engines per hour is recorded. A standard revolution counter may be so connected that every ten, hundred, thousand or ten thousand revolutions are recorded on the chart. Connection can also be made to the signaling devices and these recorded on the same chart.

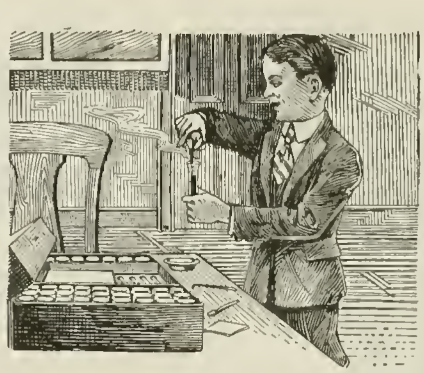
Herewith is a drawing of the spiral, the radial conductor which extends under the compass needle from the *fleur de lis* to the center and the record chart, all located in the same relative positions which they occupy in the machine. It is apparent that the distance which the spiral cuts from the *fleur de lis* or north end of the the compass box varies as the angle, and in as much as it is this distance which is indicated by means of the electric discharge upon the paper, a continuous record of the past behavior of the compass is obtained. An actual record of a cruise up Long Island Sound on board Dr. Jaeger's private yacht, the Reco, is here reproduced. The chart reveals the fact that the yacht put out of port pointing S.E. and held this course for about an hour; in approximately fifteen minutes the course was changed to E. by S. and held for forty-six hours; at this point the course was changed to N.E. by N., the change requiring one hour and a quarter, following this in six hours time the course N.E., was pursued for the remainder of the trip of twelve and one-half hours duration.

The yacht was a sailing vessel on which no engines were running, neither is there a log record hence the only information we can obtain from the chart is that it required forty-six hours to go out, six and one-half hours to partially reverse its direction and eighteen and one-half hours to put into port. The helmsmanship was good, since there are no abrupt changes in the trace of the course and furthermore one could gather that the sea was running fairly quiet, since the yacht being of small tonnage and draft would, in rough water, be forced into different courses, frequently resulting in an irregular record.

The view of the cabinet and apparatus shows the sundry special relays, controlling devices, switch gear and compensating mechanisms which are necessary for the proper operation of the recording compass. From its comprehensiveness the reader may obtain some slight idea of the vast amount of labor which was entailed in its construction.

Upon first thought it may seem as tho the magnetic needle would be affected by the electric spark which is in such close proximity. Microscopic examination of the needle while under such influence shows no effect whatever. This is explained because of the fact that the magnitude of the current is very minute or about two milliamperes, and also because the spark is an alternating current of high frequency; consequently the resultant magnetic field would be practically zero.

(*Continued on page* 206)



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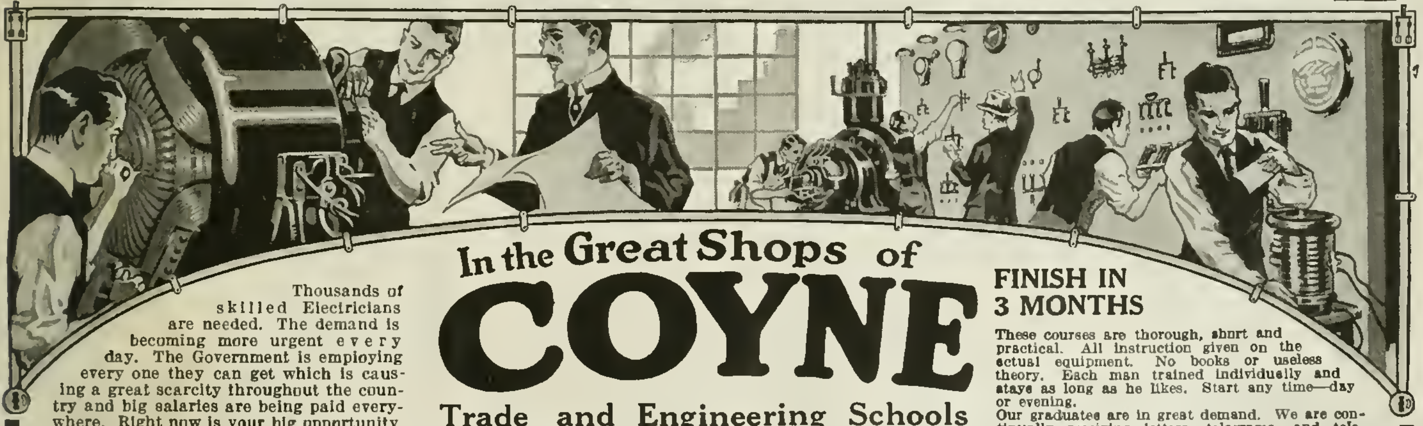

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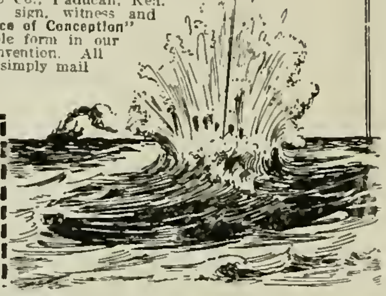

U.S. PATENTS

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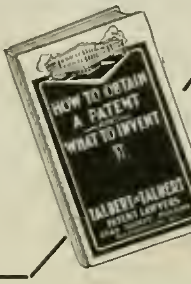

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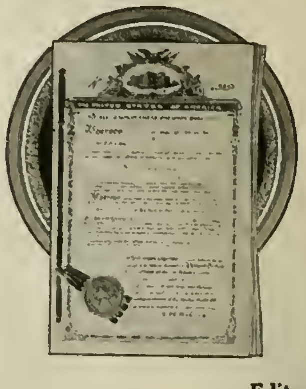


Edited by

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

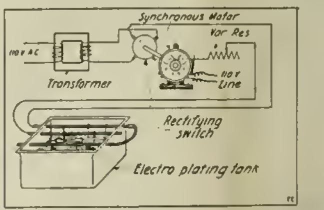
Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

With this issue we are inaugurating a new feature in our Patent Advice Department. It has been found in the past that this Department was rather dry and uninteresting to our readers. The reason for this is that in order to protect our correspondents, we did not, as a rule, divulge the idea and for this reason our answers as well as the entire correspondence were rather vague. It will be seen that in this issue, we are disclosing the device freely for the following reasons:

For one thing we are mailing the answer to our correspondents, as it is printed here, from two to three weeks before we go to press. If our correspondent thinks well enough of this answer, he has it in his power to get in touch with a patent attorney at once, if he wishes to protect his idea. At any rate, an outsider could not patent the idea which has been disclosed thru the columns of the ELECTRICAL EXPERIMENTER, *because the original inventor would no doubt file an opposition. Or, if a patent was actually issued the original claimant could institute proceedings against the infringer. For that reason the disclosure of the idea will not in any way prove detrimental, but on the other hand it will be a protection to the original inventor who can always point to the printed record as publisht in this periodical.*

Electro Plating.

(236) Robert McGill, Chicago, Ill., wants our opinion as to the patentability of a combination of a transformer, the primary of which is connected to an A. C. main, the secondary of which is connected to a rotary rectifying switch operated by a synchronous motor, run by current from the main supplying the primary of the transformer. This is connected to an electro plating outfit. Our correspondent wishes to know if this idea is patentable and practicable.



A. There is nothing very new about an idea of this kind, and it is certainly not patentable. Furthermore, we very much doubt if good plating will result from a combination of this kind, for the reason that a system of this kind will not deliver pure direct current necessary for good plating work.

Pocket Wireless.

(237) Robert N. Rose, Queens, N. Y., submits an idea to put a complete wireless outfit, phones excepted, into an ordinary watch case, using the stem by which the watch is usually wound to vary the loading coil. Our advice is asked.

A. This is a very clever idea, but not patentable as far as we can tell. There are no new features involved, similar ideas having been described in the ELECTRICAL EXPERIMENTER before.

ADVICE

H. GERNSBACK

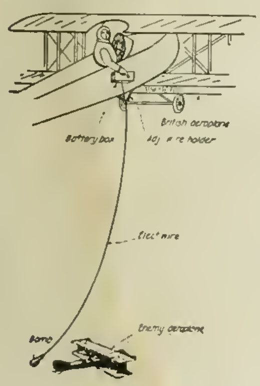
Auto Warning Device.

(238) Elmer Wahl, Carnegie, Pa., has an idea that he can make a compass arrangement to close certain contacts, so that, when an automobile passes ten feet away from it, these contacts, thru an electric current, will operate a horn located around the curve, the idea being to avoid collissions.

A. This will not work at all, one reason being that if you will buy a compass you will find that its needle does not stand still all day long, but varies thru several degrees. Local magnetic storms, as described in our editorial in the June issue, will cause a needle to fluctuate more or less; hence the alarm would not be reliable. Furthermore, an automobile rushing by ten to fifteen feet away from it, would not influence a magnetic needle sufficiently.

Aeroplane Bomber.

(239) Lawrence Arnott, London, Ontario, Can., submits an aerial offensive device consisting of a wire cable baving attached to its lower end a bomb. This contrivance is trailed behind the attacking aeroplane, and the bomb is exploded by means of an electrical contact as soon as it comes close to the enemy aeroplane. Our advice is asked.



A. This is a very clever idea, and we believe it is patentable, altho we are not sure at all that it is practicable. Aviators as a rule do not like contrivances that bave wires trailing behind on account of the entangling features, etc., but it seems to us that sooner or later they will come to use a device of this kind, particularly at the present time when the Germans have developed their "flying tanks" which are almost invulnerable against ordinary machine gun fire. Of course, the attacking aeroplane would have to do some very tall maneuvering to get the bomb close to the enemy aeroplane, but the thing certainly is not impossible. We would advise our correspondent to take out a patent on this device, altho as stated before we do not know how practical it may prove.

Hydrometer.

(240) N. Kenneth Mehaffie, Altoona, Pa., would like very much to know if the following scheme is practical. In place of making the usual form of hydrometer for general purposes, he suggests one in the form of a strip or rod of a non-absorbent material being unaffected by acids, and weighted properly at the bottom and graduated up the face or side. Our correspondent thinks that this would be a far cheaper form of hydrometer, and would be practically indestructible. While he thinks that it would not take the place of the very sensitive laboratory instrument, it might do for general purposes.

A. This is a very old idea. As a matter of fact, the very first hydrometers were constructed upon this plan. If you will look up any physics book, you will find hydrometers made of wood or the like, weighted with shot at the bottom. There is no advantage in a device of this kind, for hydrometers are selling as cheap as 25 cents a piece.

Piston Ring.

(241) John M. O'Brien encloses a sketch and description of a two-piece anti-leak piston ring.

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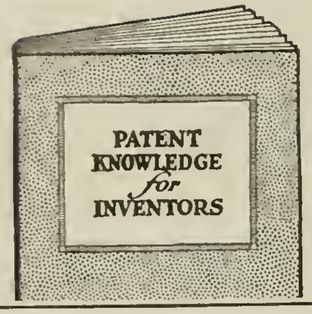

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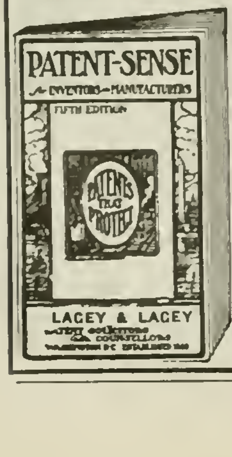

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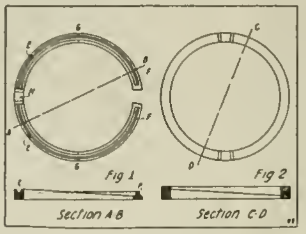
Our correspondent believes that such a ring would combine the advantages of both eccentric and concentric rings without their disadvantages, and at the same time possess the much desired leak-proof feature. Our advice is asked as to the patentability and practicability of this device.

A. The sketch which we reproduce herewith shows the idea clearly. The groove feature seems to be a particularly happy one, and to our mind it is a new idea which seems to us patentable.



On account of the wedge shape the ring will certainly prove non-leakable. We would, however, suggest trying out the idea in practise beforehand.

Flashlight Battery.

(242) T. Robertson, Hendrum, Minn., wishes to know if any patents have been granted on flash-lights having storage batteries incorporated in same. Also if they are of the wet or dry type.

A. There is nothing new about this, flashlight batteries having been sold for years in Germany as well as in France and in England by certain makers, which have small storage batteries instead of the usual dry cell device. Cells of this kind are usually of the dry storage battery type, and as a rule contain either powdered glass, glass wool or electrolyte of the gelatinous kind to make the liquid immovable.

Screwdriver.

(243) Andrew M. Boehmer, Cleveland, Ohio, submits description and illustration of a non-turning screwdriver, the handle being made of die castings. An arrangement is provided so as to lock the screw driver by means of a large nut.

A. This is a very good idea and very clever, but we are afraid the screwdriver will be too expensive to manufacture, but of course there is always a good demand for the better class screw-drivers of this kind. We think a patent may be obtained upon the device.

A NEW ELECTRIC RECORDING COMPASS.

(*Continued from page* 203)

Another seemingly fatal disadvantage one may think of at the outstart is that the spark used on the compass would send out electric waves which will interfere with the ship's wireless receiving set. That this is not the case has been demonstrated and from theoretical considerations it is apparent that an undamped electric oscillation of such short wave length, and being practically surrounded by grounded metallic parts will have no effect on the wireless equipment.

Today, after years of ceaseless toil and disappointments, the electric recording compass bids fair to become an indispensable accessory of every ship. With the ever increasing installation of recording instruments of all kinds, instantly on the alert to detect any shortcomings on the part of the machinery or crew, the recording compass has been looked upon as a necessary part of the equipment. Of what value is it to know, for instance that the boiler pressure has been kept at a constant value, that the steam engines have been functionating at the maximum efficiency, etc., when it is not known that the course has been properly maintained and that the passengers and cargo have not received that delicate care so requisite for their safety? All pilots are required to pass stringent and exacting examinations and have most excellent qualifications, but in spite of this we always lack the irrevocable proof that he has steadfastly done his duty. The recording compass puts the seal of excellency upon his work if it is good—the stamp of reproach be it bad.

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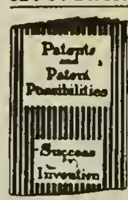

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INDEX TO

ELECTRICAL EXPERIMENTER SCIENCE & INVENTION

FOR VOLUME 1, 2, 3, 4, 5

This index contains 24 pages and shows every article of interest that has been published since the inception of the magazine up to and including April, 1918.

This index is absolutely indispensible to everybody interested in any kind of electrical research interested in any kind of electrical research work. Everything of importance in the advancement of electrical science during the last five years can be readily found by means of this index. Then if you should not have the back numbers containing certain information, these can be secured from us at the following schedule.

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ELECTRIC OR STEAM RAILROADS—WHICH?

(*Continued from page* 153)

8% efficiency. Now consider that during cold weather this same machine often loses 40% of its efficiency, due to the heat utilized in raising the temperature of the feed water. In Summer at 85° F. then 127 heat units are required per lb. of water to raise steam.

Thus it is seen that in —20° F. cold winter weather, 232 — 127, or 105 more heat units, are required per lb. of water to raise steam; or 105 ÷ 232 = 45% loss in cold weather. When the mercury falls to —40°F. and more, the steam locomotives use so much heat from their coal to heat the water from the low temperature that they often freeze up, as pointed out in the official reports of the C. M. & St. Paul Railway and other systems.

Some very vital and illuminating statistics are cited in respect to the efficiency, or rather *inefficiency* of operation of steam railroads, in the address of President E. W. Rice, Jr., before the *American Institute of Electrical Engineers* mid-winter convention. Among other things, Mr. Rice said: "Where electricity has been substituted for steam on railroads, fully 50% increase in available capacity of existing tracks and other facilities has been demonstrated. . . . Electric locomotives have permitted a speeding up of train schedules by some 25% under average conditions. In cold weather the electric locomotive actually has its hauling capacity increased at a time when the steam locomotive is using up all its energy by heat radiation from its boiler (in cold weather) and engine into the atmosphere, with the result that practically no useful power is available to move the train, the electric locomotive is operating under its most efficient conditions and may even work at a greater load than in warm weather. But this is by no means all. The railroads of the country consumed 150,000,000 tons of coal in the year 1917. *Electrification of the railroads would save at least two-thirds, or 66 2/3%, of this coal;* or electric locomotives substituted for steam types would save over 100,000,000 tons of coal in one year. This is an amount three times as large as the total coal exported from the United States during 1917."

Furthermore, careful tabulation by Government experts shows that the railroads of the United States used in 1915 twenty-four per cent, or about *one-fourth of the total coal output to run their trains.* Think of it! And again—electric haulage, as demonstrated by actual results obtained on the St. Paul, the Pennsylvania, and the Norfolk & Western, could have *saved* two-thirds of this or 100,000,000 tons of coal, equal to *five times the total amount used by all the electric central stations of the country.*

Public announcement was recently made by Sir Adam Beck, at London, Ontario, that the Canadian Pacific Railway, Canada's premier transcontinental system, and one of the world's greatest, is moving toward electrification. Sir Adam, as chairman of the Hydro-Electric Power Commission of Ontario, told the Board of Trade he was in a position to announce that the Canadian Pacific Railway had asked the Commission for figures on the cost of electrifying the Ontario lines, for estimate on the cost of electrical operation, and for an indication of the possibilities of securing a supply of power from the publicly owned hydro-electric system. He further stated that the Canadian Pacific Railway has been in touch for some time with the electrical operation of Chicago, Milwaukee & St. Paul Railway. The coal famine in Canada and *steam inefficiency in the rigorous winters,* it is reported, has directed the attention of the Canadian Pacific Railway to electric traction.

On one of the Southern coal roads, with long hauls to reach the consumer, nearly 25 per cent. of the coal output is used on the locomotives which haul the coal to market and return the "empties."

Did you ever stop to think that practically all of this 150,000.000 tons of coal consumed by the railroads has to be hauled from the coal mines to various section terminals along the line, sometimes a thousand miles or more. And again, that a considerable part of the coal is *hauled back again in the locomotive tender.* Mr. Rice, Jr., in his paper cited above, stated in this connection: "It is estimated that fully 16 per cent of the *total ton-mileage* movement behind the engine draw-bar is made up of *company coal and coal cars,* including in this connection the steam engine tender and its contents. There is available in the United States 25,000,000 H.P. of water power; if this were developed and could be used in driving our railroads, each horse-power so used would save at least 6 pounds of coal per horse-power hour now burned under the boilers of our steam locomotives.

Water is consumed in enormous quantities by all steam locomotives, of course—millions of gallons of it annually. The illustration herewith serves to show how this great bulk of water has to be pumped and piped or purchased, as in cities, and distributed all along the line at intervals of 20 to 30 miles. Based on the fact that the 65,000 steam locomotives in the country operated about half the time, or, let us say, half the year, then they would consume something like 9½ billion tons of water, or over 2 trillion gallons every year.

The two illustrations herewith show the latest high-power electric and steam locomotives respectively, together with their horse-power ratings and losses along the systems on which they operate. The engines are about equal in size and strength and give a clear idea of their relative efficiency. As already mentioned, the steam engine realizes about 7% gross efficiency, whereas the electric locomotive shown, developing 4,000 H.P., shows a gross efficiency of 89%. This means but little in a way; rather, it is the over-all efficiency of the entire electrified railroad system that really tells the tale. Here are the facts.

Efficiency of Electrified Railroad.

With hydro-electric power (ordinarily without regenerative braking), gross efficiency from water power to locomotive = 56%. *In the case of the C. M. & St. Paul R. R., the engines deliver power back to the system when coasting down mountains to the amount of* 15%. *Hence the gross or over-all efficiency here equals* 71%.

With mouth-of-mine centralized electric generating, stations, gross efficiency from coal burned to electricity delivered to locomotives = 10 *to* 12 *per cent. This eliminates company coal and water haulage, reducing the labor required incidentally.*

With "natural gas" engine plants, gross efficiency from gas used to electrical energy delivered to locomotives = 24 *to* 30%.

With "gas producer" plants operating on coal at mouth of mine, the gross efficiency from coal burned to the electrical energy delivered to the locomotives = 24 *to* 28%.

Present Steam Railroad Efficiency.

With coal-burning locomotives, gross effi-

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ciency from coal burned to power delivered to driving wheels = 7 to 8%. This value is reduced to about 3½, actually, owing to the hauling and re-handling of the coal, water, extra labor, coal cars, tied up etc., etc.

TABLE OF LOSSES IN HYDRO-ELECTRIC RAILROAD SYSTEM.

	Efficiency.	H. P. Delivered.
Assumed 1000 H.P. at water-fall.		
Water turbine	82%	820
A. C. Generator	96%	787
Step-up Transformers	97%	764
A. C. Transmission Line	95%	726
Step-down Transformers	97%	704
Sub-station Converter	94%	662
D. C. Feeder Circuit	95%	629
Electric Locomotive	89%	559

Hence gross efficiency or per cent of water power transformed into electrical energy, transmitted over high tension line; converted into direct current, and finally changed into mechanical energy at driving wheels of electric locomotive $= \frac{559}{1000} = .559$ or 55.9%. Total losses = 100—55.9 = 44.1% of power in water-fall. This is for fairly large systems developing 20,000 to 50,000 H. P. at least. Small hydro-electric systems show an over-all efficiency of about 50 per cent.

In the case of the C. M. and St. Paul Railway, however, the net gross efficiency of the hydro-electric system is boosted by the locomotives generating current while running down mountain grades, thus returning 15% of the energy used by regenerative braking.

The gross efficiency for that electrification is thus:—100% + 15% regained by regeneration = 115%, and 115% minus 44.1 loss = 70.9% efficiency, or over ten times the efficiency shown by the best steam locomotives under practical road conditions.

Consider the steam locomotive here illustrated. The engine itself weighs 271 tons, or about the same as the electric locomotive complete, and as it is the weight on the drivers that governs the tractive or hauling power, it should be capable of pulling the same load as its electric brother, but it cannot, for the reason that it must also haul along its "dinner" in the form of a 102-ton tender, carrying 12,000 gallons of water and 16 tons of fuel. This is mostly excess baggage—if the 102-ton tender were eliminated, as electrification now does, the same engine could haul from 5 to 6 cars more in its train.

The electrifying of a large railroad system is, however, a vast and extremely expensive proposition, and altho the scheme of electrifying such a stretch of track as between New York and Chicago, a distance of some 800 miles, has been projected by some engineers in the past few years the railroads have, in general, been content to try out these schemes on a more conservative and economical basis.

The application of electric traction to several of the great terminal systems of such railroads as the Pennsylvania and New York Central lines has served to prove beyond a doubt that, when properly utilized, electricity is at once the most readily controlled, efficient, and satisfactory source of power extant.

The steam engine has served us well for over half a century now, but, like other great inventions of mankind, it has about reached its utmost. both in point of operating efficiency, speed limit, and general service, and will in the not far distant future give preference to a newer and more efficient means of transportaion.

The many advantages of electricity for transportation purposes will become fully utilized in a highly efficient and practical manner, when the water-fall is harnest to the railroad train thru the medium of an electrical generating and distributing system, which has already been applied in Europe, and other countries, to lines of very considerable length. When a modern hydro-electric power system is employed to supply the electric current, a gross efficiency of 50 to 70 per cent is realized.

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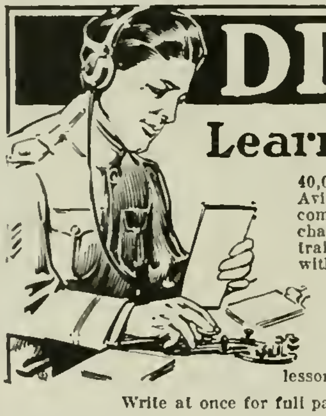

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So much for the operating efficiency of the railroad employing electric traction; now we will take a look at the speed aspect of the problem, about which there has been evidenced much doubt of late among railroad engineers and in the publications devoted to their interests, the principal argument being, that, "as the electrical engineer promised such wonderful speeds a few years ago, when electric locomotives were first introduced, why does he not show us a little proof of the pudding?" This question is partly answered by the fact that no orders have been given up to this time for an electric locomotive capable of making better speeds than those at present maintained by steam locomotives; also, if they were built the existing rolling stock and roadbed could not withstand the terrific strain imposed by higher speeds than 100 to 110 miles an hour, this being the present limit.

Another question often hurled at the electrical engineer is, "Why don't the electric locomotive show a greater speed than it does on trial trips, etc.?" The reason why it does not seem to be capable of outstripping its steam rival lies in the fact that it was not designed for that purpose; on the contrary, it was designed and built to conform to certain rigid specifications as supplied by the purchasers, and to date they have succeeded in fulfilling all the conditions so imposed. As an example, the new electric locomotives supplied to the Pennsylvania R. R. for hauling its trains through the North River tunnels into its New York City terminal had to be capable of starting and accelerating a 550-ton train on a two per cent tunnel grade, and also of hauling a full train at 60 miles per hour. The electric "Mogul" lived up to the demands made of it, and that was all that was required. If the contract had read 120 miles an hour, then the engine being built for such speeds, would have fulfilled the contract, as it is capable of being designed to perform any of the "stunts" made by its steam friend to-day.

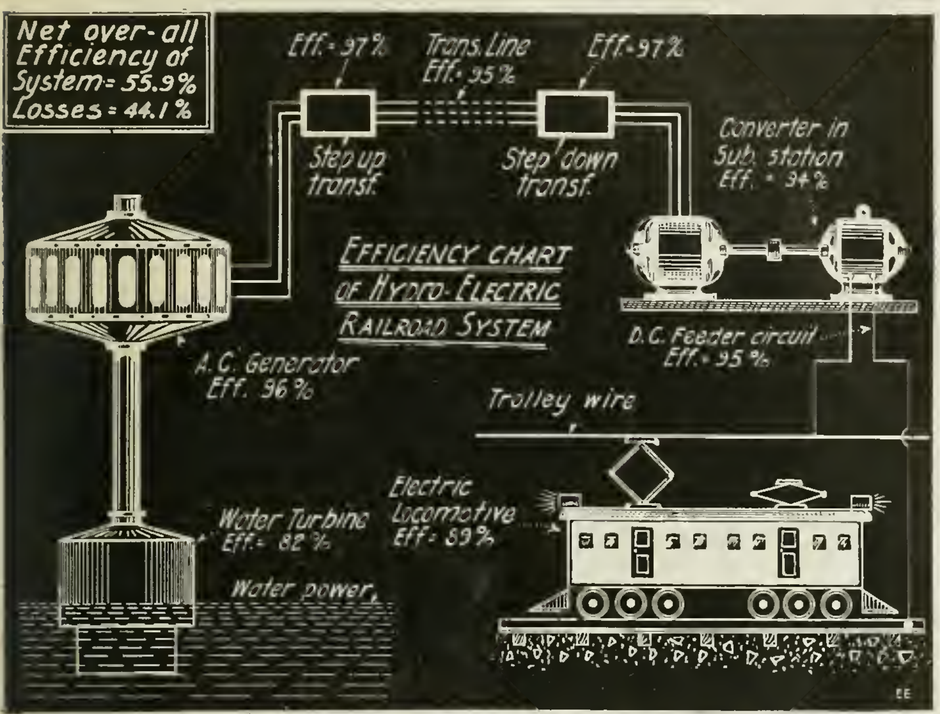
Years ago, in 1903 to be exact, a number of vastly important tests and researches were carried out by a body of engineers in Germany, between the cities of Berlin and Zossen, over a stretch of especially prepared track. The electric potential at the trolley wire was 40,000 volts, 3-phase alternating current, with step-down transformers on the cars. The front of the cars were equipt with pointed wind shields, and the maximum speed attained was 130 *miles an hour*, which became possible without any unreasonable demands of power.

To attain any speeds of this magnitude or higher with a steam locomotive, the power necessitated would require that the locomotive have such elephantine proportions that it would consume a large percentage of the power developed in *propelling itself*, due to the reason that the power demanded at such high speeds increases at a higher ratio than the square of the speed.

In speaking of the results obtained from the Berlin-Zossen tests, Dr. Louis Bell, one of the foremost electrical engineers of the day, said: "They show clearly that it is entirely feasible to run electric trains at speeds greatly exceeding those now usual, and this without demanding any unreasonable amount of power."

As thousands of horse-power in the form of electrical energy is now transmitted 250 miles and more, it is perfectly feasible to electrify such a line as from New York to Chicago, with but three or four power stations distributed along the line. The most important desiderata in such a large project as this is the tremendous initial outlay required, and the way in which this will most likely be accomplisht will be to electrify different sections of the line, one after the other, allowing the expense to be spread over a number of years, at the end of which time the entire electrification will be complete.

Finally,—it is not impossible,—we of this generation may see the 150-mile an hour train, perhaps a mono-rail train, when we can lunch in New York, have dinner in Chicago, and possibly breakfast in 'Frisco. This is the age of endless wonders, and the only question the engineer asks is, "What next?"



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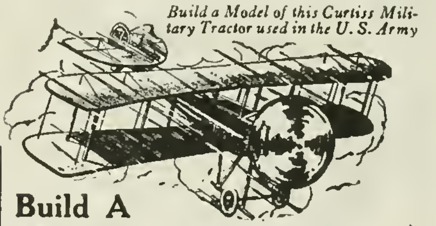

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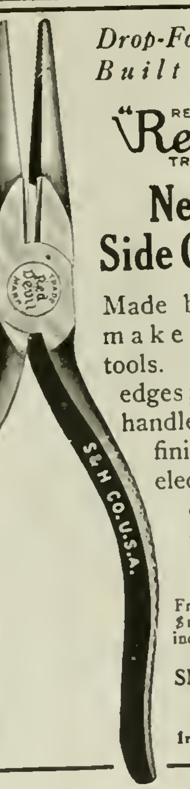

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THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page* 176)

crowded thru the diafram will simply be wasted in magnetic leakage as shown at X in Fig. 1-B. With diaframs of given diameter, a thicker one carries more lines, is stiffer and can, therefore, be brought nearer to the pole-pieces, but a limit to *thickness* is soon imposed by the increase of stiffness and inertia, and also by the decrease in the natural period of vibration, which should also be in the neighborhood of the periodicity of the current sent thru the receiver. The factor d Φ, due to the current, is improved for a given current by increase of the number of turns of wire linked with the magnetic circuit; but when the applied E. M. F. is supposed given, the resistance of the windings has to be considered, which implies that the spools should be of small section and as nearly circular as possible. The spools are usually placed at the extreme ends of the soft iron pole-pieces, from which it follows that the pole-pieces must be reduced in section as far as possible without unduly increasing the reluctance of the magnetic circuit. As the diafram of the actual receiver is a stretched elastic body but tends to vibrate most easily and perfectly at a frequency, dependent upon its construction and elastic properties, which is known as its *natural frequency,* hence it is found that if the input current to the receiver is kept constant in amplitude, but if its frequency is varied, then the greatest response or motion of the diafram occurs when the *imprest* frequency *is identical* to the *natural* frequency of the diafram.

A factor which has been given considerable attention of late in the study of both radio and telephone receivers is that known as the *motional impedance.* Those interested in this subject will do well to consult an excellent paper giving a complete study of the telephone receiver diafram by Messrs. Kennelly and Affel, *Proc. Amer. Acad. Arts & Sci., Nov.,* 1915. Motional impedance as applied to the telephone receiver concerns the current induced in the receiver windings by the *movement of the diafram.* In other words, whenever the diafram of the receiver moves or vibrates, it changes the reluctance of the magnetic circuit, and in consequence changes the flux thru the windings, thus causing an E. M. F. to be induced in them. If this were not so, the regular telephone receiver of the type here shown would not transmit speech without a battery connected in circuit with it. When the receiver has current past thru it and the diafram vibrates in consequence, the induced E. M. F. flows in an opposite direction to the current entering the windings and is a *counter E. M. F.* Thus, in the case of any telephone or radio receiver the *total impedance* of the windings is composed of *two* impedances, the *first* being that of the receiver winding, and the *second,* that of the reaction of the moving diafram.‡

In any event the total pull on the diafram of a telephone receiver is made up of three terms—one representing the pull due to the permanent magnetism alone, one representing the pull due to the current alone, and a *product term* representing the pull due to the super-position of two magnetic fields, *viz.,* those due to the current and to the permanent magnet.

TYPES OF RECEIVERS

Several of the more distinct types of wireless receivers will now be discust. Several unique features of construction are shown in Fig. 2. At A there is shown one style of permanent magnet used considerably in bipolar watch-case type receivers, and as will be observed, the pole-pieces are secured to either side of the circular steel magnet rings. It may also be said at this point that the two magnet coils are invariably connected in series and arranged to produce alternate *North* and *South* poles as indicated in the figure. At B there is shown a common arrangement of the watch-case 'phone and its steel magnet rings. Another form of watch-case receiver magnet

‡ Mills, "Radio Communication," 1917.

AN ELECTRIC HOUR-STRIKING MECHANISM.

(*Continued from page* 182)

nubbin strikes *LL* and ends the game. The process continues for the succeeding hours, till at 12 o'clock the rack *S* falls thru its widest arc, the pin S^1 striking the snail at its lowest point W^4.

The layout of the snail is shown in Fig 2. The distance from W^1 to W^4 is just equal to twelve teeth on the rack, so make your rack first. Use for the rack a section of any old big clock gear wheel, filing the teeth over into the new shape required; then make your snail to correspond. In Fig. 1 the teeth are supposed to be 1/16 in. apart.

A word in regard to the forked trigger *CC*. The object of this is to give the magnet the longest pulling-time, and yet break the circuit at the end of the stroke. The contact holds on until the hammer-stem strikes the point CC^2, when the curved top and the spring *KK* are separated at *JJ;* and they remain apart until the returning stem strikes CC^1, when they are wedged together for another pull of the magnet. Of course the pivot *DD* must be muffled slightly, so that *CC* will stay where it's put, and not swing freely.

This rinktum may look complicated at first sight, but if you'll analyze it you'll find it's very simple and not hard to make. It's more work to describe it than to make it. So go to it, "Bugs," with my blessing.

MAKING A SIX-FOOT PIANO LAMP.

(*Continued from page* 178)

Connect the ends of the wires to the proper places on the inside of the socket and assemble it.

Remove the silk and cotton from about one foot of the cord that extends above the top of the post, leaving the rubber only. Now screw the nipple into the bottom of the brass stand and screw the flange onto the nipple. Pass the rubber covered wires up thru the stand and into the recess at the top. Bare the ends of these wires. Bare a short space on the wires that lead from the socket where the wires that come up from the stand meet them. Connect these wires and tape the joints. Take the other socket apart, fasten the top part to the other nipple and tighten the set screw. Pass the cross wires thru the nipple and top of the socket; connect them to the inside as before and assemble the socket. (Fig. 5 is a diagram of the electrical connections).

Screw the flange to the top of the post and draw the wire tight from the bottom.

Glue the bottom of the post into the hole in the base and draw the wire tight from the outside.

The lamp is now ready for finishing. You may do this yourself if you think you are proficient in the art, but the best way is to take it to a man who is in the business; the result will pay.

We are now ready for the shade. These are made in a great variety of shapes and colors. You may buy the shade complete or simply buy the frame and have it covered. Either way is satisfactory.

Near the top of the shade is a ring which fits over the rod extending from the top of the stand and sets on top of the recess. The brass nut then screws down to hold it.

[The author's name for this article has been lost and if he will communicate with the Editor, credit will be given him in the August issue.]

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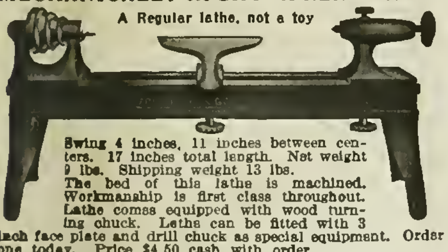

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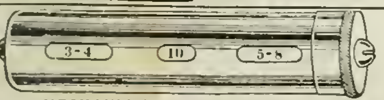

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is shown at C. This arrangement may comprise a permanent steel magnet, X, with an electro-magnet, Y, secured at the center. The diafram is then acted upon in this case at the center, and also at both sides. Some single-pole receivers utilize a permanent magnet punching similar to that illustrated at D. In this case the magnetic flux from the single-pole near the diafram has to return thru the air, thus encountering considerable *reluctance* (magnetic resistance) of course, and these receivers are therefore not as efficient as the double-pole type, as the magnetic reluctance of air is several hundred times greater than it is for iron or steel. At E, Fig. 2, a typical pole-piece from a bipolar watch-case receiver is illustrated, where 1 and 2 are the fiber end-cheeks which are slipt over the pole-piece preparatory to winding the coil on it. The face of the pole-piece which is next to the diafram is swaged over as shown to hold the coil check in place. It is common practice to provide several narrow slots as shown in the drawing, these slots extending from the face of the pole-piece to the bottom of the coil section. Several of the best makes of wireless 'phones have these slotted pole-pieces, which tend to reduce the losses due to *Eddy currents,* which are produced in the face of the pole of any receiver whenever the diafram moves and represent a loss in efficiency, develop heat, etc. All of the best grades of wireless 'phones are provided with some form of protective spark-gap or other device as shown at Fig. 2-F to prevent heavy static or other surges from burning out the windings in the receiver. A very small condenser is sometimes connected across the binding-post terminals of the receiver or else a high resistance. If a spark-gap is used for the apparatus, it should be of the micrometer type provided with threaded electrode screws so that it can be adjusted very closely, the gap not being over .01 inch in length.

Fig. 3 illustrates a *vibrating reed radio receiver* patented by S. G. Brown in England. This receiver is of the watch-case type having a shell, A, and an ear-piece or cap, B. The vibrating member comprises a steel reed, E, and a light, conical, aluminum diafram, F, attached at its center thru the reed, E, and at a point a short distance from the center of the core axis. The conical diafram has its perifery close up against the casing. The central portion of the reed is cut away so as to make it more flexible, and also in this way it becomes possible to provide a tuned vibrating member, or a set of these members adapted to currents of various periodicities.

A unique type of *mono-telephone* is illustrated in Fig. 4. This receiver has a vibrating member arranged to be tuned to any definite frequency within its range. With such a 'phone it becomes possible, by simply turning a thumb-screw on the exterior of the shell, to adjust its armature to have a natural period of vibration corresponding to the frequency of the current applied to the windings. In the mono-telephone shown at Fig. 4, a light ferrotype diafram is secured between a tight wire and a fixt axle. The pitch or period of vibration is adjusted by the thumb-screw and worm which control the tension of the wire. The electro-magnets and so forth are of the same type as used in all watch-case telephone receivers. Where the ordinary spark signals are to be interpreted or picked up, it has not been found particularly efficacious to use mono-telephone receivers, for the reason that the ordinary spark is very rich in overtones, and when a receiver is tuned to the spark rate, the energy of the fundamental is collected by the diafram, and that of the overtones thrown away.

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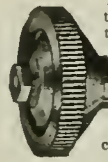

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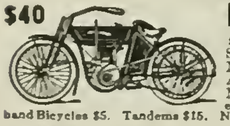

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The *condenser* or *electro-static receiver*, as it is more commonly known, is based upon the fact that a condenser can reproduce speech when connected into a suitable circuit. The electro-static or condenser receiver was first successfully applied by Prof. Dolbear. Elisha Gray, in 1875, found it possible to produce sounds using the *dry fingers*, and he also at that time described a form of musical telegraph receiver based upon *electro-static attraction*.

Fig. 5 illustrates an improved form of *electro-static* telephone receiver. This receiver is provided with a sound-conducting tube and ear-piece, and at its base carries a sound-reflecting plate, as the drawing shows. In this particular design India rubber was found best for the condenser leaves, owing to its high insulating properties and low dielectric losses. An aluminum shell is provided as shown, which has an opening at the top and over which the alternating rubber and metal foil leaves are stretched. These rubber and foil leaves are firmly secured around the perifery to prevent any irregular vibration. Each rubber leaf is about .4 m.m. thick. The sound-reflecting plate at the base of the receiver serves to reflect any sounds emanating from the inner surface of the condenser. The plates for the condenser are composed of aluminum leaf about .001 m.m. thick, these aluminum leaves being secured to the rubber leaves by a special process. When this form of receiver was tried with two hundred and forty volts, it was found that the volume was equal to that of an electromagnetic *loud-speaking receiver* and the volume increased substantially with three hundred and four hundred volts, respectively. One of these condenser telephone receivers made and tested by Messrs. Ort & Rieger had a capacity of .088 m.f.

Several investigators have endeavored to produce a more efficient and perfect type of telephone receiver involving the heating and cooling of a fine electrical conductor. This principle is utilized in the *thermal telephone* shown at Fig. 6. This is probably the simplest form of telephone receiver ever designed, and of recent years has been quite successfully developed in Europe, notably by Mr. DeLange. The receiver consists merely of a small tube provided with an opening, the tube being small enough to fit in the outer ear. The active member comprises a short loop of stript Wollaston wire secured to two heavy lead wires in the manner indicated. In practice the tube containing the fine Wollaston wire is inserted in the aural passage: any sudden heating of this fine wire by a small current creates an air pulse or sound wave vibration which in turn affects the ear drum. It has been found advantageous in some cases to have a small current passing permanently thru the loop.

The *electro-dynamic* receiver is illustrated in Fig. 7. This is also known as a *dynamometer* telephone and was designed by Prof. G. W. Pierce for use with his type of wave-meter. This receiver is not as sensitive as the regular type, but for certain purposes it possesses many advantages, one of them being that it can be connected directly in series with the condenser and exploring inductance of a wave-meter (provided it is calibrated in connection with the wave-meter, thus allowing for the inductance of the winding in the receiver) as in the Pierce wave-meter, in which case it will indicate the resonance point by giving a maximum strength of signal, the same as when a detector and a pair of 'phones are used. The construction of the dynamometer telephone is very simple, comprising as it does, a hard rubber or other insulating bobbin on which the magnet coil is wound, having a resistance of from seventy-five to one hundred and fifty ohms, and in front of this there is placed a light copper or silver diafram. No iron is used in the receiver, and its action is based upon the fact that attraction is set up between the current in the coil and the induced current in the silver or copper diafram. As Shepardson points out, even the diafram may be omitted, the minute movements of a loosely wound coil of wire being sufficient to reproduce speech or signals.

The *Baldwin amplifying receiver* is one of the latest developments in wireless receiving instruments and possesses a remarkable sensitivity. Its sponsors state that this receiver will amplify the incoming signals as high as nine times. A number of tests were made at the Radio Laboratory of the College of the City of New York with very gratifying results, this particular receiver having showed very superior results. As shown in the illustration, it comprises a permanent steel magnet which is provided with soft iron pole-pieces of the shape indicated, and between which there is placed the electro-magnetic winding of high resistance, also a light, balanced, soft iron armature pivoted at the center. One end of this armature is connected by a brass wire or link to a mica or isinglass diafram of standard size. The receiver shell is of normal size, altho to those not familiar with this particular instrument such might not seem the case off-hand. Whenever a fluctuating current passes thru the telephone winding, the soft iron armature is caused to vibrate, and these vibrations are transferred to the diafram by the link already mentioned. As becomes evident, this receiver is unlike all other electro-magnetic receivers, in that the armature is under no magnetic strain until an incoming current passes thru the winding. This is so, owing to the fact that the flux from the permanent magnet divides equally between both sides of the U-shaped, soft iron poles and continues thru the magnets. Owing to this division of the magnetic flux, there is therefore no constant strain on the armature, as is the case in the common telephone receiver, as we learned in the fore-part of this article. The superior sensitivity of this receiver is due to several reasons, among which are the following: the magnetic circuit has a very low reluctance, and also the armature of the magnet is under no artificial strain until the current passes thru the winding, thus yielding a greater deflection of the diafram, and again the armature is acted upon at both ends, and since the flux is produced differentially, the deflection for a given magnetizing current is correspondingly increased.

Fig. 9 shows a type of radio receiver developed several years ago, in which the pole-pieces are made adjustable by virtue of a small thumb-screw protruding thru the back of the shell. As aforementioned, this type of 'phone permits the operator to correct the length of the air gap whenever the strength of the signal requires it, or also when temperature changes may cause the diafram to sag and touch the pole-pieces. For strong signals, the operator can thus increase the length of the air gap, and for weak signals he can advance the pole-pieces until they almost touch the diafram.

Another excellent type of adjustable air gap radio receiver is shown at Fig. 10. This is the "Leach" *adjustable diafram* receiver, the diafram being rigidly locked in the adjustable cap, so that whenever the cap is turned on the shell, the diafram will be caused to recede from or advance toward the magnetic pole-pieces. The diafram is locked in the cap by means of a threaded ring. This 'phone has a graduated scale secured on the shell as shown, and an indicator is mounted or engraved on the edge of the movable cap. Thus when an opera-

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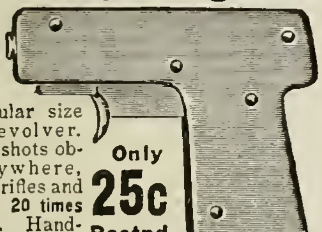

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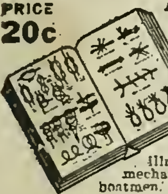

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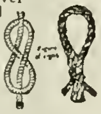

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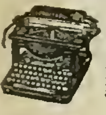

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tor has once found a certain point on the scale which gives good results, he can reset the cap and diafram to that particular point whenever desired.

A novel form of *monotone* receiver is illustrated in section at Fig. 11, this particular type having been used with great success in submarine telegraphy and telephony. It was devised by a New York electrical engineer, Mr. Christian Berger, inventor of the submarine telegraph system now used on ocean-going vessels and submarines. This receiver is similar in design to other electro-magnetic types, and is provided with a permanent steel magnet. The novel feature of this receiver which puts it in the monotone class lies in the design of the special diafram. This diafram is comparatively heavy, even as thick as one-quarter of an inch in some cases, and as the reader will observe, it is not supported in the ordinary manner between the shell and cap of the receiver, but is mounted on its central axis upon a rigid stud secured to a brass block between the magnet poles. When a current of the proper periodicity or frequency is past thru the windings of this receiver, and providing the proper diafram, tuned to this exact frequency is utilized, then the fullest response possible with this form of instrument will be had; the tuned, tempered steel diafram of the bell type, vibrating at its own natural period with a maximum amplitude. Many unique modifications of this principle have been devised by Mr. Berger, and with this form of diafram the purest note imaginable is obtained.

At Fig. 12-A, there is illustrated the "Fessenden" heterodyne receiver which will translate and reproduce signals from an undamped wave radio station by the well-known principle of *beats*. Thus if an incoming signal has a frequency of fifty thousand cycles per second and this current is past thru a light magnet coil secured to the diafram of the receiver, while an auxiliary radio frequency current, having a periodicity of either forty-nine thousand or fifty-one thousand cycles per second, is past thru a stationary magnet coil mounted on an iron wire core as shown in the illustration, then the difference between these two frequencies, or, one thousand cycles per second will be the *beat* frequency or the note heard in the 'phone.

A form of telephone receiver which seems to have considerable promise, and which has been used in Europe, is the *Ader* receiver, illustrated at Fig. 12-B. This receiver is of the watch-case type and similar to a number of other receivers, being provided with a circular ring-shaped steel magnet on the poles of which are placed the two magnet coils. An iron diafram is used, and in front of this diafram there is placed an iron ring known as the *super-exciter*. The iron ring in front of the diafram tends to strengthen the action of the armature as it acts to render the field of the magnetic force more intense. Several telephone authorities have stated that they believe that the intensive effect of this type of receiver could be still further increased if the entire mouthpiece were made of soft iron. An interesting watch-case receiver used in Europe is the *Goloubitsky* type. This resembles the Ader receiver, but does not have the iron ring in front of the diafram, and is fitted with a second steel ring set at right-angles to the first one, and having two magnet coils placed on its poles. Thus, there are four electro-magnets acting on the diafram, all of the coils being joined in series. This form of receiver gives better results than those with two coils, but the extra weight does not compensate for the slight gain in efficiency obtained, it is claimed.

(*To be continued*)

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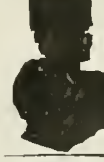

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The assurance of this speaker—in the crowded corridor of the Hotel McAlpin—compelled me to turn and look at him, though I must say it is not my usual habit to "listen in" even in a hotel lobby.

"He is David M. Roth, the most famous memory expert in the United States," said my friend Kennedy, answering my question before I could get it out. "He will show you a lot more wonderful things than that, before the evening is over."

And he did.

As we went into the banquet room the toastmaster was introducing a long line of the guests to Mr. Roth. I got in line and when it came my turn, Mr. Roth asked, "What are your initials, Mr. Jones, and your business connection and telephone number?" Why he asked this, I learned later, when he picked out from the crowd the 60 men he had met two hours before and called each by name without a mistake. What is more, he named each man's business and telephone number, for good measure.

I won't tell you all the other amazing things this man did except to tell how he called back, without a minute's hesitation, long lists of numbers, bank clearings, prices, lot numbers, parcel post rates and anything else the guests gave him in rapid order.

****

When I met Mr. Roth again—which you may be sure I did the first chance I got—he rather bowled me over by saying, in his quiet, modest way:

"There is nothing miraculous about my remembering anything I want to remember, whether it be names, faces, figures, facts or something I have read in a magazine.

"*You can do this just as easily as I do.* Anyone with an average mind can learn quickly to do exactly the same things which seem so miraculous when I do them.

"My own memory," continued Mr. Roth, "was originally very faulty. Yes it was—a really *poor* memory. On meeting a man I would lose his name in thirty seconds, while now there are probably 10,000 men and women in the United States, many of whom I have met but once, whose names I can call instantly on meeting them."

"That is all right for you, Mr. Roth," I interrupted, "you have given years to it. But how about me?"

"Mr. Jones," he replied, "I can teach you the secret of a good memory in one evening. This is not a guess, because I have done it with thousands of pupils. In the first of seven simple lessons which I have prepared for home study, I show you the basic principle of my whole system and you will find it—not hard work as you might fear—but just like playing a fascinating game. I will prove it to you."

He didn't have to prove it. His Course did: I got it the very next day from his publishers, the Independent Corporation.

When I tackled the first lesson, I suppose I was the most surprised man in forty-eight states to find that I had learned—in about one hour—how to remember a list of one hundred words so that I could call them off forward and back without a single mistake.

That first lesson *stuck*. And so did the other six.

Read this letter from C. Louis Allen, who at 32 years is president of a million dollar corporation, the Pyrene Manufacturing Company of New York, makers of the famous fire extinguisher:

> "Now that the Roth Memory Course is finished, I want to tell you how much I have *enjoyed* the study of this most fascinating subject. Usually these courses involve a great deal of drudgery, but this has been nothing but pure *pleasure* all the way through. I have derived much benefit from taking the course of instructions and feel that I shall continue to strengthen my memory. That is the best part of it. I shall be glad of an opportunity to recommend your work to my friends."

Mr. Allen didn't put it a bit too strong.

The Roth Course is priceless! I can absolutely *count* on my memory now. I can call the name of most any man I have met before—and I am getting better all the time. I can remember any figures I wish to remember. Telephone numbers come to mind instantly, once I have filed them by Mr. Roth's easy method. Street addresses are just as easy.

The old fear of forgetting (you know what that is) has vanished. I used to be "scared stiff" on my feet—because I wasn't *sure*. I couldn't remember what I wanted to say.

Now I am sure of myself, and confident, and "easy as an old shoe" when I get on my feet at the club, or at a banquet, or in a business meeting, or in any social gathering.

Perhaps the most enjoyable part of it all is that I have become a good conversationalist—and I used to be as silent as a sphinx when I got into a crowd of people who knew things.

Now I can call up like a flash of lightning most any fact I want right at the instant I need it most. I used to think a "hair trigger" memory belonged only to the prodigy and genius. Now I see that every man of us has that kind of a memory if he only knows how to make it work right.

I tell you it is a wonderful thing, after groping around in the dark for so many years to be able to switch the big searchlight on your mind and *see* instantly everything you want to remember.

This Roth Course will do wonders in your office.

Since we took it up you never hear anyone in *our* office say "I guess" or "I think it was about so much" or "I forget that right now" or "I can't remember" or "I must look up his name." Now they are right there with the answer—like a shot.

Have you ever heard of "Multigraph" Smith? Real name H. Q. Smith, Division Manager of the Multigraph Sales Company, Ltd., in Montreal. Here is just a bit from a letter of his that I saw last week:

> "Here is the whole thing in a nutshell: Mr. Roth has a most remarkable Memory Course. It is simple, and easy as falling off a log. Yet with one hour a day of practice, anyone—I don't care who he is—can improve his Memory 100% in a week and 1,000% in six months."

My advice to you is don't wait another minute. Send to Independent Corporation for Mr. Roth's amazing course and see what a wonderful memory you have got. Your dividends in *increased earning power* will be enormous.

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